1up

A UNITED STATES
DEPARTMENT OF
COMMERCE
PUBLICATION

NOAA Technical Report NWS 14

File as COM-71-50383

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service

Weekly Synoptic Analyses, 5-, 2-, and 0.4-Millibar Surfaces for 1968

STAFF, UPPER AIR BRANCH,
National Meteorological Center

FACILITY FORM 602

N71-36971	
(ACCESSION NUMBER)	(THRU)
173	G3
(PAGES)	(CODE)
CR-122938	20
(NASA CR OR TMX OR AD NUMBER)	(CATEGORY)

SILVER SPRING, MD.

May 1971

NOAA TECHNICAL REPORTS
National Weather Service Series

The National Weather Service (NWS) makes observations and measurements of atmospheric phenomena, develops and distributes forecasts of weather conditions and warnings of adverse weather, and collects and disseminates weather information to meet the needs of the public and specialized users. The NWS develops the national meteorological service system and the improved procedures and techniques for weather and hydrologic measurements and forecasts and for their dissemination.

NWS series of NOAA Technical Reports is a continuation of the former series, ESSA Technical Report Weather Bureau (WB).

Reports 1 to 3 are available from the National Technical Information Service, U.S. Department of Commerce, Sills Bldg., 5285 Port Royal Road, Springfield, Va. 22151. Price: $3.00 paper copy; $0.95 microfiche. Order by accession number, when given, at end of each entry. Beginning with 4, Reports are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

ESSA Technical Reports

WB 1 Monthly Mean 100-, 50-, 30-, and 10-Millibar Charts January 1964 through December 1965 of the IQSY Period. Staff, Upper Air Branch, National Meteorological Center. February 1967. (AD 651 101.)

WB 2 Weekly Synoptic Analyses, 5-, 2-, and 0.4-Mb Surfaces for 1964 (based on observations of the Meteorological Rocket Network during the IQSY). Staff, Upper Air Branch, National Meteorological Center. April 1967. (AD 652 696.)

WB 3 Weekly Synoptic Analyses, 5-, 2-, and 0.4-Mb Surfaces for 1965 (based on observations of the Meteorological Rocket Network during the IQSY). Staff, Upper Air Branch, National Meteorological Center. August 1967. (AD 662 053.)

WB 4 The March-May 1965 Floods in the Upper Mississippi, Missouri, and Red River of the North Basins. J. L. H. Paulhus and E. R. Nelson, Office of Hydrology. August 1967. Price $0.60.

WB 5 Climatological Probabilities of Precipitation for the Conterminous United States. Donald L. Jorgensen, Techniques Development Laboratory. December 1967. Price $0.40.

WB 6 Climatology of Atlantic Tropical Storms and Hurricanes. M. A. Alaka, Techniques Development Laboratory. May 1968. Price $0.20.

WB 7 Frequency and Areal Distributions of Tropical Storm Rainfall in the United States Coastal Region on the Gulf of Mexico. Hugo V. Goodyear, Office of Hydrology. July 1968. Price $0.35.

WB 8 Critical Fire Weather Patterns in the Conterminous United States. Mark J. Schroeder, Office of Meteorological Operations. January 1969. Price $0.40.

WB 9 Weekly Synoptic Analyses, 5-, 2-, and 0.4-mb Surfaces for 1966 [Based on meteorological rocketsonde and high-level rawinsonde observations]. Staff, Upper Air Branch, National Meteorological Center. January 1969. Price $1.50.

WB 10 Hemispheric Teleconnections of Mean Circulation Anomalies at 700 Millibars. James F. O'Connor, National Meteorological Center. February 1969. Price $1.00.

WB 11 Monthly Mean 100-, 50-, 30-, and 10-Millibar Charts and Standard Deviation Maps, 1966-1967. Staff, Upper Air Branch, National Meteorological Center. April 1969. Price $1.25.

WB 12 Weekly Synoptic Analyses, 5-, 2-, and 0.4-Millibar Surfaces for 1967. (Based on meteorological rocketsonde and high-level rawinsonde observations). Staff, Upper Air Branch, National Meteorological Center. January 1970. Price $1.50.

NOAA Technical Reports

NWS 13 The March-April 1969 Snowmelt Floods in the Red River of the North, Upper Mississippi, and Missouri Basins. Joseph L. H. Paulhus, Office of Hydrology. October 1970. Price $1.25.

U.S. DEPARTMENT OF COMMERCE
Maurice H. Stans, Secretary
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Robert M. White, Administrator
NATIONAL WEATHER SERVICE
George P. Cressman, Director

NOAA Technical Report NWS 14

Weekly Synoptic Analyses 5-, 2-, and 0.4-Millibar Surfaces for 1968

(Based on meteorological rocketsonde and high-level rawinsonde observations)

STAFF, UPPER AIR BRANCH,
National Meteorological Center

SILVER SPRING, MD.
MAY 1971

This report was prepared with support of the National Aeronautics and Space Administration under contract P-44664(G).

UDC 551.509.21:551.506.7:551.507.362 1:551.508 822 (7) "1968-53"

551.5	Meteorology
.509.	Synoptic meteorology
.21	Synoptic charts
.506.	Periodical observational data
.7	Upper air data
.507.	Instrument carrier
.362.1	Rockets
.508.	Meteorological instruments
.822	Radiosondes – Rawinsondes
(7)	North America
"1968-53"	Weekly during 1968

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON: 1971

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - Price $1.50
Stock Number 0318-0017

Contents

PAGE

Introduction ---------- 1

Processing of rawinsonde data ---------- 1

Processing of rocketsonde data ---------- 2

Analysis procedure ---------- 3

Discussion of the 1968 charts ---------- 4

Acknowledgments ---------- 6

References ---------- 6

Station Model and Reporting Rocket Stations ---------- 13

Weekly 5-, 2-, and 0.4-mb synoptic charts ---------- 14-169

LIST OF ILLUSTRATIONS

FIGURE

1. Analyzed values from weekly charts at Fort Greely ---------- 7
2. Analyzed values from weekly charts at Fort Churchill ---------- 8
3. Analyzed values from weekly charts at Wallops Island ---------- 9
4. Analyzed values from weekly charts at White Sands ---------- 10
5. Analyzed values from weekly charts at Antigua ---------- 11

Weekly Synoptic Analyses, 5-, 2-, and 0.4-Millibar Surfaces for 1968

(Based on meteorological rocketsonde and high-level rawinsonde observations)

STAFF, UPPER AIR BRANCH

National Meteorological Center, NOAA, Hillcrest Heights, Md.

ABSTRACT. Data from meteorological rocketsonde and rawinsonde observations have been employed to analyze a series of high-altitude synoptic charts. Methods employed for processing the various types of data and the analysis procedure used are described.

Broad-scale analyses of the 5-, 2-, and 0.4-mb surfaces, primarily covering North America and adjacent ocean areas, are presented at weekly intervals for 1968. A brief discussion of the height and temperature fields is also given. Circulation and temperature changes associated with a major stratospheric warming during January are among the discussion items.

INTRODUCTION

This volume represents the fifth in a series of constant-pressure charts for the upper stratosphere, based on rocketsonde and very high level rawinsonde data obtained over North America and adjacent ocean areas. These charts have been analyzed by the Upper Air Branch of the National Weather Service's National Meteorological Center (Staff 1967a, 1967b, 1969, 1970).

At 5 mb, both rawinsonde and rocketsonde data were used to derive the height and temperature fields. Above 5 mb, rawinsonde data were seldom available, and rocket observations constituted the basic data source. The Station Model and Reporting Rocket Stations chart (p. 13) shows the locations of 20 meteorological rocket launch sites within the map analysis area for which data were available in 1968.

The present series of analyses at weekly intervals includes charts for the 5-, 2-, and 0.4-mb surfaces (approximately 36, 42, and 55 km, respectively), nominally representing broad-scale synoptic conditions on each Wednesday of the analysis period. In addition to a description of the techniques employed in obtaining these charts, a brief discussion of large-scale features is also included.

PROCESSING OF RAWINSONDE DATA

The preparation of high-level data for analysis presents many problems. Some of the difficulties encountered in the use of rawinsonde information, such as achieving compatibility between daytime and nighttime observations, extrapolation and interpolation of data, and identification of erroneous reports, have been summarized previously (Finger et al. 1965, 1966).

Temperature and height adjustments designed to compensate for instrumental radiation errors were applied to all 5-mb rawinsonde reports. Initially, an adjustment was made which reduced values from daytime observations to the level of those values reported from nighttime observations. Magnitudes of these day-night adjustments, which are intended to account for the

effects of solar heating on the rod thermistor, were determined with the aid of a computer program that calculated monthly mean differences between reported daylight and darkness values. Input to this program consisted of all available 5-mb data for 1964 and 1967 from stations in North America and adjacent ocean areas that employ U.S. outrigger-type radiosonde instruments (for details of the adjustment and further references, see McInturff and Finger 1968).

Theoretical and laboratory studies of the rod thermistor used in present-day radiosondes indicated that a significant error may be induced by infrared cooling at stratospheric levels above about 10 mb. Therefore, a second adjustment (Barr 1966) was added to all reported 5-mb data, including observations made actually in darkness and daytime data that had been adjusted for solar-radiation error. The magnitude of the temperature correction is a function of reported temperature, while the height adjustment varies linearly with the temperature correction.

Rawinsonde data utilized for the 5-mb charts were processed by computer methods. Inputs to the computer program consisted of observations from North America and adjacent ocean areas for 7-, 5-, 4-, and 3-mb levels in the form of punched cards obtained from the National Weather Records Center. Output listings included all observations for 1 week at each station. Data for levels other than 5 mb were also listed to supply the analyst with as much supplementary information as possible. Thermal winds and corresponding horizontal temperature gradients were computed for the layers from 7 to 5, 7 to 4, and 5 to 4 mb.

After processing, the rawinsonde-derived temperature, height, wind, and thermal wind were plotted on work charts. For charts presented in this publication, the rawinsonde data have been omitted for the sake of legibility.

PROCESSING OF ROCKETSONDE DATA

Winds and termperatures measured by rocketsonde systems comprised the basic data sample for analyses at the 2- and 0.4-mb levels, and were also used in combination with rawinsonde data for the 5-mb charts. Rocketsonde information was obtained for this project in the form of magnetic tape, identical in format to published information contained in the *Meteorological Rocket Network* (MRN) *Firings* (World Data Center A 1969).

The procedure for extraction of rocketsonde information and for computation of heights of the 5-, 2-, and 0.4-mb surfaces was as follows:

a. Wind and temperature profiles were processed by a computer program, designed to reduce the amplitude of rapid oscillations in the vertical by using a simple (1-2-1) smoothing technique. This processing was done because analyses are intended to portray only the broad-scale stratospheric features.

b. Temperatures were modified above 40 km in accordance with Drews' (1966) publication, one of several theoretical studies (see the review article by Ballard 1967). For the Arcasonde 1A, the instrument most widely employed during 1968, the correction applied to the temperature profiles increased from 1°C at 42 km to about 9°C at 58 km.

c. An initial estimate of the geopotential height for each station at the respective pressure levels (5, 2, and 0.4 mb) had to be made before the temperature for that particular level could be selected. This estimate was obtained by deriving the temporal trend of the geopotential height for the station from the lower level analyzed charts and by applying this trend to the geopotential height for the station as shown by the previously analyzed chart. The temperature at this estimated height was then extracted from the temperature profile.

d. The true geopotential height of the pressure surface at each station was then hydrostatically computed for each available temperature profile. This height was obtained by deriving a layer-mean temperature between the extracted temperature of the upper level and the temperature obtained from the previously completed lower level analysis. Computer-analyzed 10-mb charts (Environmental Science Services Administration 1968), based exclusively on rawinsonde data, were used as foundation for hydrostatic computation of the height of the 5-mb surface. For the 5- and 2-mb levels, a constant lapse rate was considered representative. However, because a temperature maximum (associated with the stratopause) usually exists between 2 and 0.4 mb, mean temperatures were derived by using values extracted at each whole kilometer between these two pressure levels.

e. Wind components were extracted from the smoothed profiles at the height of the constant-pressure surface, and a resultant wind was computed.

f. Thermal winds were determined for 6-km layers surrounding each pressure surface at the reporting station.

The rocketsonde data (temperature, height, wind direction and speed, and thermal wind) were plotted on work charts. On the charts presented for publication, three observations are shown when available for each station. Heights and thermal winds have been omitted for the sake of legibility. The Station Model and Reporting Rocket Stations chart illustrates the symbols used to distinguish the data obtained on Wednesdays from off-time data.

ANALYSIS PROCEDURE

Conventional techniques, including differential analysis methods, were used to construct the 5-, 2-, and 0.4-mb charts. However, because of the sparsity of observations, data acquired for the entire week were examined to determine the synoptic changes that took place during the week. Thus, conditions pertaining to Wednesday, the analysis day, were deduced.

The analysis system consisted of the following steps:

a. Isotherms were derived using both processed rocketsonde and rawinsonde temperatures where available. In spite of the corrections applied to the 5-mb rawinsonde temperature data, large differences could sometimes be seen when comparing rocketsonde data that were close in time and distance (Muench 1971). Generally, the problem could be resolved by giving greater weight to rawinsonde stations employing hypsometers. In a few cases, the difficulty even occurred with hypsometer radiosondes; therefore, some compromise value had to be chosen, usually closer to the rocketsonde-reported temperature. Computed thermal winds were especially useful in determining horizontal temperature gradients and the relative location of warm and cold areas. Where possible, time-height sections of temperature were plotted as a further aid in deriving the isotherms.

b. A mean temperature field representative of the layer between the previously analyzed lower surface and the selected surface was derived graphically. This mean field represents a geopotential thickness which, when added to the lower level height field, yields a smooth, conservative first approximation to the contour pattern at the upper surface.

c. Reported winds and computed heights for individual stations were then used to adjust the first approximation of the contour field, using the assumption of geostrophic flow. Winds were accorded the highest priority for this adjustment. When large adjustments were made to the contour field, the temperature field was then adjusted to maintain hydrostatic consistency.

d. The analysis was reviewed for vertical and temporal consistency. For example, circulation centers, ridges, and troughs were examined with the aid of all available data to verify vertical slope and movement with time. Time-height sections and height-change charts were especially useful for these purposes.

The above procedures appear to produce excellent results at 5 mb, and were successfully applied to obtain the 2- and 0.4-mb charts. Generally, only slight adjustments of the first-approximation height fields were necessary at the 5- and 2-mb levels. However, rather formidable analysis problems were evident at the 0.4-mb level. One problem arises from the apparent intersection of the stratopause with the 0.4-mb level. Because the normal stratospheric temperature inversion ceases at the stratopause level, the graphical method for obtaining mean temperature, which depends on the existence of a linear profile, is no longer valid. Large adjustments must be made, especially at lower latitudes, in the graphically derived height field to conform with the computed height at each station (as discussed in the previous section).

Another difficulty was the apparent occurrence of large day-to-day temperature changes at times exceeding 10°C (Miller 1969) and persistent oscillations in many wind profiles. In most cases, deviations of reported temperatures and winds from one another could be accounted for by identifiable rapid large-scale synoptic changes. Sometimes reports within a few hours of each other at a single station exhibited temperature changes of 5° to 7°C over a limited height interval near the stratopause. It has been shown that such small-scale subsynoptic changes are possible at these levels (Miller and Schmidlin 1971). Thus, some intermediate value was chosen for analysis to represent the value on the analysis day. Occasionally, it was impossible to make a reasonable reconciliation of reported station values.

An additional problem is encountered in the summer charts. During that season, circulation at the upper surfaces (2 and 0.4 mb) would be expected to follow the pattern established for lower levels, that is, a rather uniform easterly flow about an anticyclone

centered at or very near the North Pole. However, on a typical summertime 0.4-mb chart, most reported rocketsonde winds exhibit significant southerly components. If these winds were to be given full weight in the analysis, the resulting pattern would consist of contours, oriented from southeast to northwest, spiraling toward a high center located apparently over northern Europe.

The prevalence of positive meridional components in summertime rocketsonde winds has been noted previously (Miers and Beyers 1964). Studies (Reed et al. 1966) based on MRN data for several summers have demonstrated that the meridional wind component resulting from the diurnal tide reaches maximum southerly strength at about noon, local time. Because most MRN firings occur near local noon, the measured winds naturally contain this component. Although no adjustments were made in individual reports, the analysis procedure includes suitable compensation. Differences in the reported winds and orientation of the contours may be quite pronounced, especially on the summertime charts. Strong westerly winds of winter usually mask the weak diurnal component, but there is a possibility that this component may contribute to some bias in analysis during periods of weak circulation.

Although careful consideration of high-level data allows a broad-scale depiction of circulation patterns up to 0.4 mb, the sparsity of reports requires an increasing amount of subjectivity as the analysis proceeds to this high level. As yet, the analyst has little in the way of synoptic models for guidance with respect to the probable contour and isotherm patterns and the phase relation between these patterns in areas of sparse data. The geographical area of analysis for the charts has thus been reduced in accordance with the available data. The justification for some analyses depends on the interpretation of the limited amount of data in such a way as to portray a coherent sequence of synoptic events. In spite of these factors, surprisingly little alteration in the principal features of the circulation and temperature distribution shown in the final analysis can be made without inordinately violating some of the data. In general, the contours and isotherms depicted are felt to be good approximations to the flow and temperature patterns at these levels. Even so, the same degree of accuracy that is found customarily in the analysis of charts at lower levels should not be expected.

A contour interval of 320-geopotential meters (gpm) was used throughout the year. In addition, intermediate dashed contours were used to outline areas of relatively weak gradient, especially during the spring and fall changeover periods. Isotherms were drawn and labeled at 5°C intervals.

DISCUSSION OF THE 1968 CHARTS

The temperature and circulation anomalies associated with the major stratospheric warming that began in December 1967 (Johnson 1969, Staff 1970) persisted into the beginning of 1968. Maximum temperatures had been observed at the end of December, with a reversal of the normal wintertime temperature gradient between the North Pole and middle latitudes occurring first at the highest levels, then proceeding downward to lower levels. Thus, at 5 mb on January 3, a wave-two pattern in the isotherms and contours was clearly seen, with the warm air stretching over the Pole associated with the two cyclones and with the cold air in the Bering Sea and the Atlantic Ocean associated with the two anticyclones. At 2 mb, cold air had returned to the polar area, with a warm area apparent over western Canada. Hydrostatically consistent with this situation was a weakening of the circulation at 2 mb and a disappearance of the North Atlantic anticyclone at the 0.4-mb level, with a strong anticyclone apparent in the eastern Pacific. The major effects of the stratospheric warming had thus diminished at the upper levels, but were propagating downward with time and were still evident at lower altitudes. By January 10, anticyclonic circulation dominated the polar region at 5 and 2 mb, but at 0.4 mb the polar cyclone had become reestablished. During the next week, the transition back to a relatively undisturbed westerly circulation could be noted at 2 mb; and by January 24, this became the pattern at the 5-mb level.

During February, the polar cyclone intensified at all levels but did not attain the depth reached before the warming. The cold air at 5 and 2 mb was somewhat displaced from the Pole toward northern Canada, whereas at 0.4 mb, warm air extending from northern Siberia dominated the polar area. Although perturbations in the temperature fields at high latitudes were noted throughout February and March, no significant departures from the basic westerly circulation of the polar vortex were observed.

The final springtime change from winter to summer conditions could be seen at the end of March at 5 and 2 mb. A warm area was first seen north of Alaska and moved over the polar region. In association with the warm area, anticyclonic circulation developed in mid-April over the Kamchatka-Alaska

region. The anticyclonic circulation was displaced northward, and an easterly circulation dominated the polar region by the end of April. The cyclonic circulation, with its associated cold westerlies, was displaced southward during May as the polar anticyclone intensified and expanded. By the end of May, the middle and upper stratosphere over the entire Northern Hemisphere was under the influence of summer easterly circulation, with the warm air centered at the Pole.

The summertime polar anticyclone warmed further during June and gradually intensified. Peak temperature and height at the Pole were reached toward the beginning of July, with maximum wind reported near subtropical latitudes. Thereafter, the anticyclone decayed slowly as the duration of sunshine decreased in Arctic latitudes. Cyclonic circulation formed in the polar area at the end of August and spread as the high latitudes cooled. The easterly circulation was displaced southward in the form of cellular ridges reaching low latitudes at the end of September and merging into the subtropical circulation. Thus by October, westerly circulation predominated over middle and high latitudes of the Northern Hemisphere stratosphere; in low latitudes, a variable easterly circulation was associated with fluctuations of the position of the subtropical ridge.

During October, November, and December, the polar cyclone deepened, accompanied by increasing westerly winds over most of the area. However, several eastward pulsations of the Aleutian anticyclone resulted in disturbances of the westerly flow over Alaska and northwestern Canada. The anticyclone first appeared on November 6 as a weak disturbance at 5 mb over the eastern Pacific. By November 20, the anticyclone was found over Alaska at all analysis levels. Rapid intensification as well as an eastward movement occurred during the next week, affecting the circulation as far east as Fort Churchill, Canada. After the initial pulse the anticyclone retrograded, but it persisted although less intense during the rest of December. High temperatures were seen during this period in a warm ridge stretching from the Caribbean to southern Europe and across Asia to eastern Siberia. This subtropical system sloped northward with height in hydrostatic response to the warm air at higher levels. By December 18, the warm air at 2 mb over southern Europe exhibited measured temperatures higher than 0°C. At the same time, the axis of cold air elongated and split with one center visible over central Canada. At the 0.4-mb level, the data indicated a considerably disturbed temperature field during the last week of the year, with warm air apparent over the polar region and cold air displaced southward.

The principal features of the circulation during 1968 at five representative rocket launch sites may be seen in the time sections (figs. 1–5) of analyzed height and temperature values extracted from the weekly charts. The annual trend of the height and temperature values is most pronounced at the middle- and high-latitude stations (figs. 1–3), with the largest range of values occurring in the more northerly stations (Johnson and Gelman 1968). Superimposed on this annual trend, characterized by maximum values in summer and minimum values in winter, are various perturbations. The largest of these perturbations was in January and was associated with the major stratospheric warming mentioned above. Smaller scale disturbances associated with movements of the Aleutian anticyclone were seen in November and December. At the tropical station of Antigua, West Indies Associated State (W.I.A.S.), the range of values is very small, with only very minor perturbations affecting the station (fig. 5). There is a suggestion, however, of a double maximum at the time of the equinoxes associated with the semiannual variation in temperature and wind and related to the seasonal migration of the subtropical anticyclone as seen in the charts. At the subtropical station of White Sands, N. Mex. (fig. 4), a combination of the major annual variation and the semiannual variation is apparent. (This discussion prepared by Melvyn E. Gelman.)

ACKNOWLEDGMENTS

Funds for the analysis of the 1968 chart series were provided by the National Aeronautics and Space Administration under contract P 44664 (G).

Personnel actively engaged in the analysis project were: Project Manager, F. G. Finger; Project Analyst, M. E. Gelman; Research Consultant, A. J. Miller; Data Processing, D. L. Griffith and J. A. Booth; and Computer Operations, K. W. Johnson.

REFERENCES

Ballard, H. N., "A Review of Seven Papers Concerning the Measurement of Temperature in the Stratosphere and Mesosphere," *ECOM* 5125, U.S. Army Electronics Command, Fort Monmouth, N.J., May 1967, 67 pp.

Barr, W., *Corrections of Radiational Error of Radiosonde Temperature Measurements in the Stratosphere,* U.S. Army Electronics Command, Fort Monmouth, N.J. 1966 (personal communication).

Drews, W. A., "A Thermistor Arrangement to Improve Temperature Measurement at High Altitude," *NASA Contract Report* 533, Aug. 1966, 29 pp.

Environmental Science Services Administration, Weather Bureau, *Constant Pressure Charts,* MF-494, National Weather Records Center, Asheville, N.C., 1968.

Finger, F. G., Woolf, H. M., and Anderson, C. E., "A Method for Objective Analysis of Stratospheric Constant-Pressure Charts," *Monthly Weather Review,* Vol. 93, No. 10, Oct. 1965, pp. 619-638.

Finger, F. G., Woolf, H. M., and Anderson, C. E., "Synoptic Analyses of the 5-, 2-, and 0.4-Millibar Surfaces for the IQSY Period," *Monthly Weather Review,* Vol. 94, No. 11, Nov. 1966, pp. 651-661.

Johnson, K. W., "A Preliminary Study of the Stratospheric Warming of December 1967 – January 1968," *Monthly Weather Review,* Vol. 97, No. 8, Aug. 1969, pp. 553-564.

Johnson, K. W., and Gelman, M. E., "Temperature and Height Variability in the Middle and Upper Stratosphere During 1964-1966 as Determined From Constant Pressure Charts," *Monthly Weather Review,* Vol. 96, No. 6, June 1968, pp. 371-382.

McInturff, R. M., and Finger, F. G., "The Compatibility of Radiosonde Data at Stratospheric Levels Over the Northern Hemisphere," *ESSA Technical Memorandum* WBTM DATAC 2, Silver Spring, Md., Dec. 1968, 61 pp.

Miers, B. T., and Beyers, N. J., "Rocketsonde Wind and Temperature Measurements Between 30 and 70 Km for Selected Stations," *Journal of Applied Meteorology,* Vol. 3, No. 1, Feb. 1964, pp. 16-26.

Miller, A. J., "A Note on the Variability of Temperature as Indicated by Rocketsonde Thermistors," *Journal of Applied Meteorology,* Vol. 8, No. 1, Feb. 1969, pp. 172-174.

Miller, A. J., and Schmidlin, F. J., "Rocketsonde Repeatability and Stratospheric Variability," *Journal of Applied Meteorology,* Vol. 10, No. 2, April 1971, pp. 320-327.

Muench, H. S., "Temperature Measurements in the 30- to 40-Kilometer Region," *Monthly Weather Review,* Vol. 99, No. 2, Feb. 1971, pp. 158-160.

Reed, R. J., McKenzie, D. J., and Vyverberg, J. C., "Diurnal Tidal Motions Between 30 and 60 Kilometers in Summer," *Journal of the Atmospheric Sciences,* Vol. 23, No. 4, July 1966, pp. 416-423.

Staff, Upper Air Branch, National Meteorological Center, "Weekly Synoptic Analyses 5-, 2-, and 0.4-Mb Surfaces for 1964 (Based on Observations of the Meteorological Rocket Network During the IQSY," *ESSA Technical Report* WB 2, Silver Spring, Md., Apr. 1967a, 176 pp.

Staff, Upper Air Branch, National Meteorological Center, "Weekly Synoptic Analyses, 5-, 2-, and 0.4-Mb Surfaces for 1965 (Based on Observations of the Meteorological Rocket Network During the IQSY," *ESSA Technical Report* WB 3, Silver Spring, Md., Aug. 1967b, 173 pp.

Staff, Upper Air Branch, National Meteorological Center, "Weekly Synoptic Analyses, 5-, 2-, and 0.4-Mb Surfaces for 1966 [Based on Meteorological Rocketsonde and High-Level Rawinsonde Observations]," *ESSA Technical Report* WB 9, Silver Spring, Md., Jan. 1969, 169 pp.

Staff, Upper Air Branch, National Meteorological Center, "Weekly Synoptic Analyses, 5-, 2-, and 0.4-Millibar Surfaces for 1967 (Based on Meteorological Rocketsonde and High-Level Rawinsonde Observations)," *ESSA Technical Report* WB 12, Silver Spring, Md., Jan. 1970, 169 pp.

World Data Center A, Meteorology, *Data Report, Meteorological Rocket Network Firings 1968,* Vol. V, National Weather Records Center, Asheville, N.C., 1969.

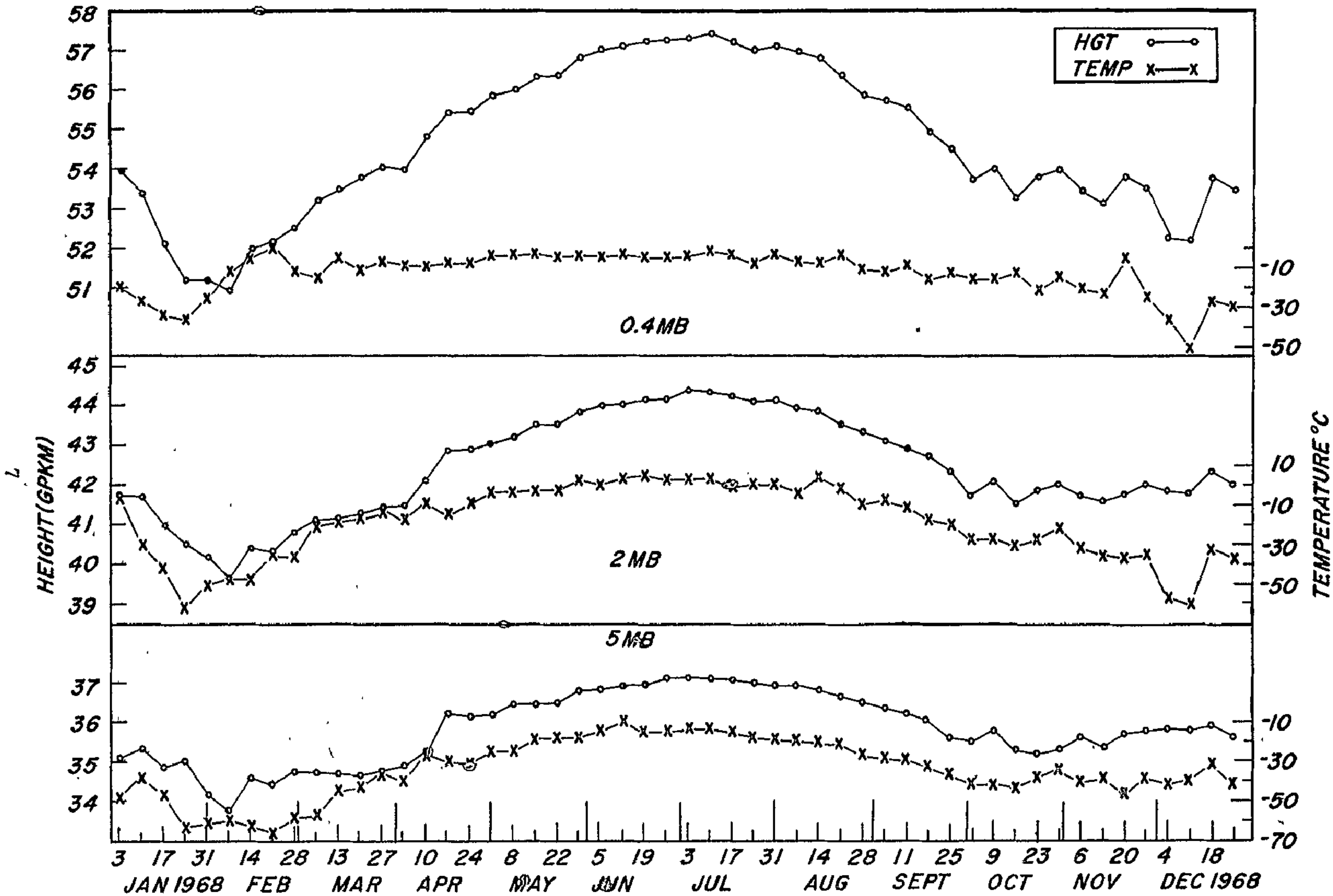


FIGURE 1.—Fort Greely, Alaska (64°00′N., 145°44′W.), analyzed values extracted from weekly 5-, 2-, and 0.4-mb charts.

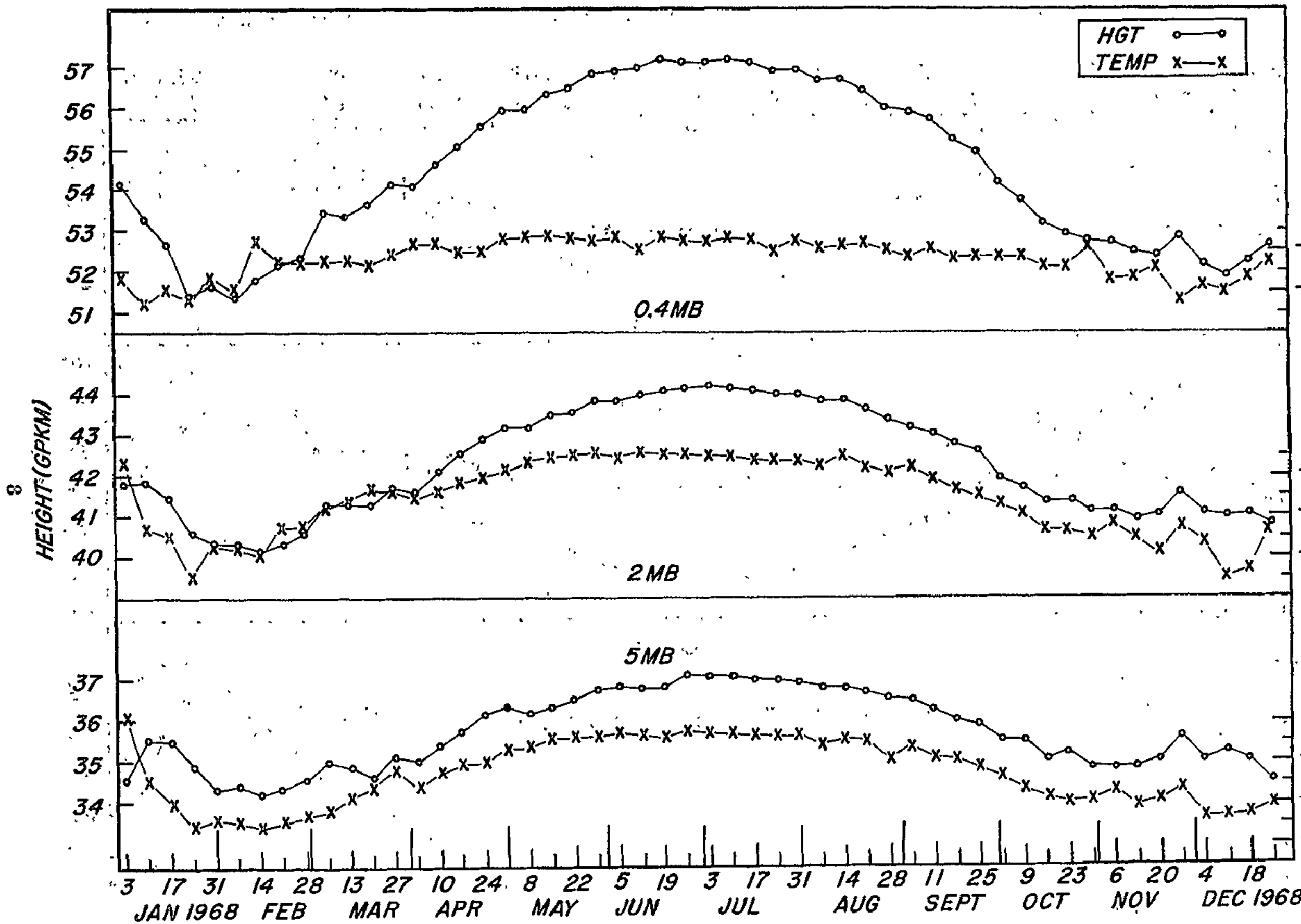


FIGURE 2.—Fort Churchill, Canada (58°44′N., 93°49′W.), analyzed values extracted from weekly 5-, 2-, and 0.4-mb charts.

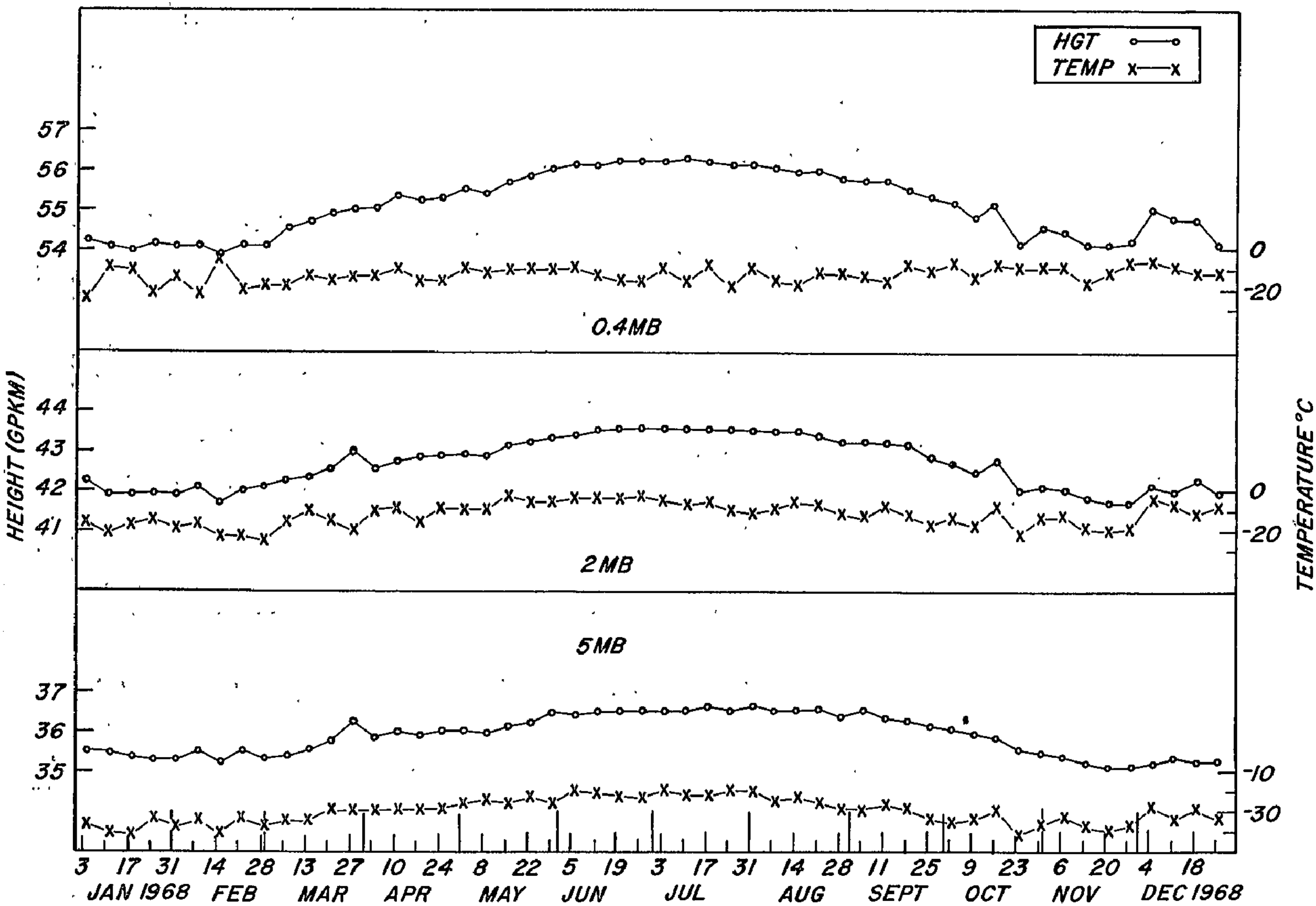


FIGURE 3.—Wallops Island, Va. (37°50′N., 75°29′W.), analyzed values extracted from weekly 5-, 2-, and 0.4-mb charts.

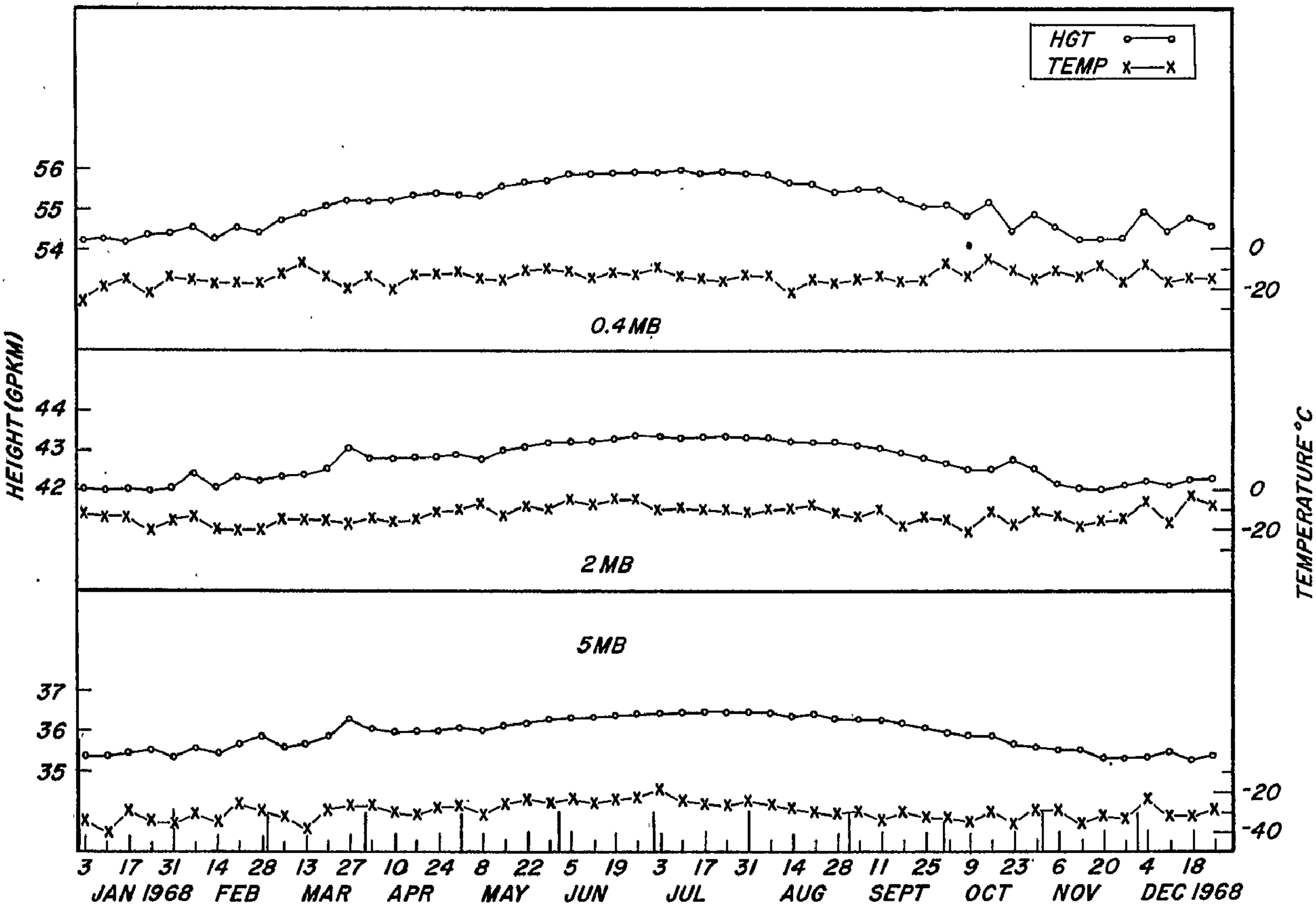


FIGURE 4.—White Sands, N. Mex. (32°23'N., 106°29'W.), analyzed values extracted from weekly 5-, 2-, and 0.4-mb charts.

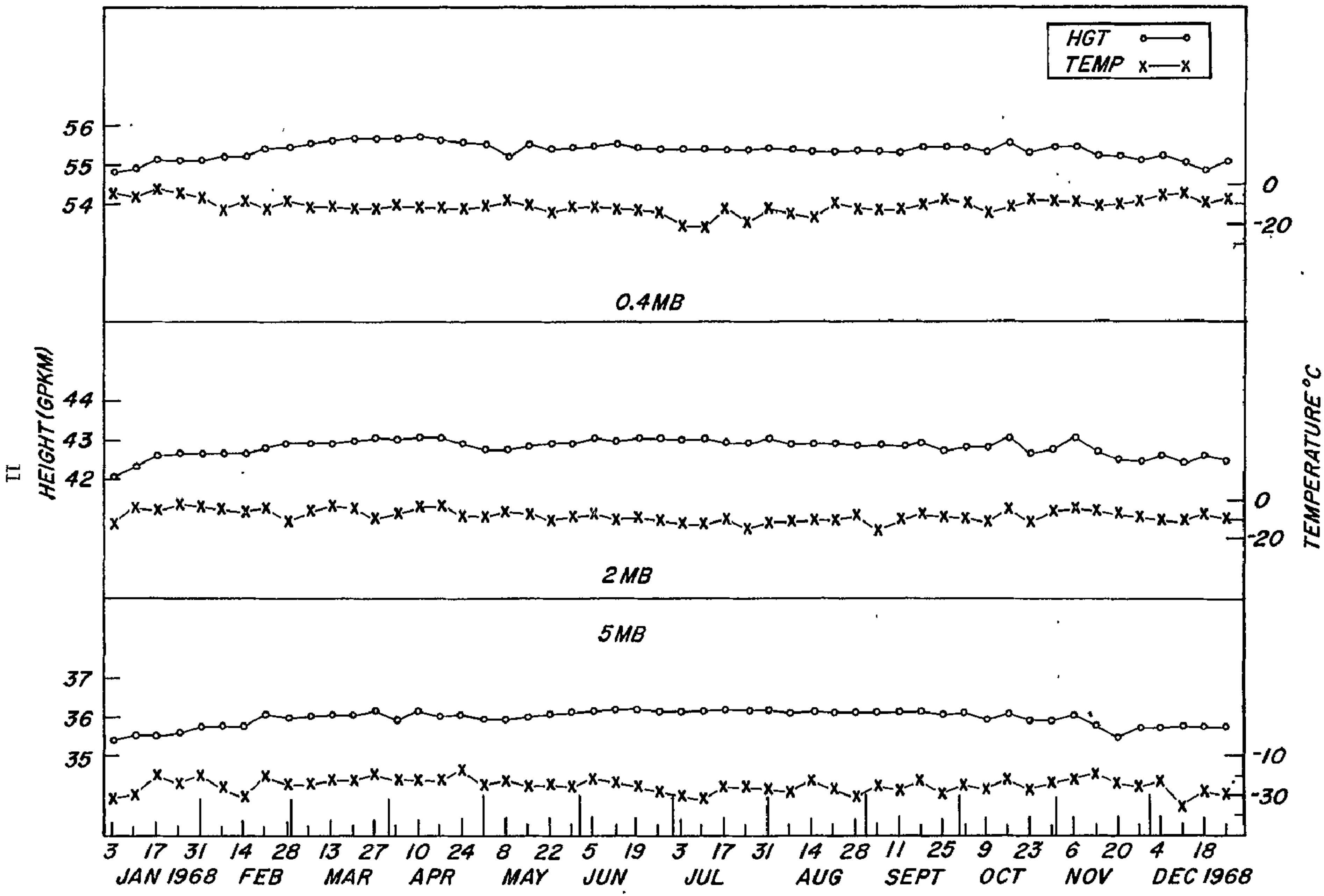
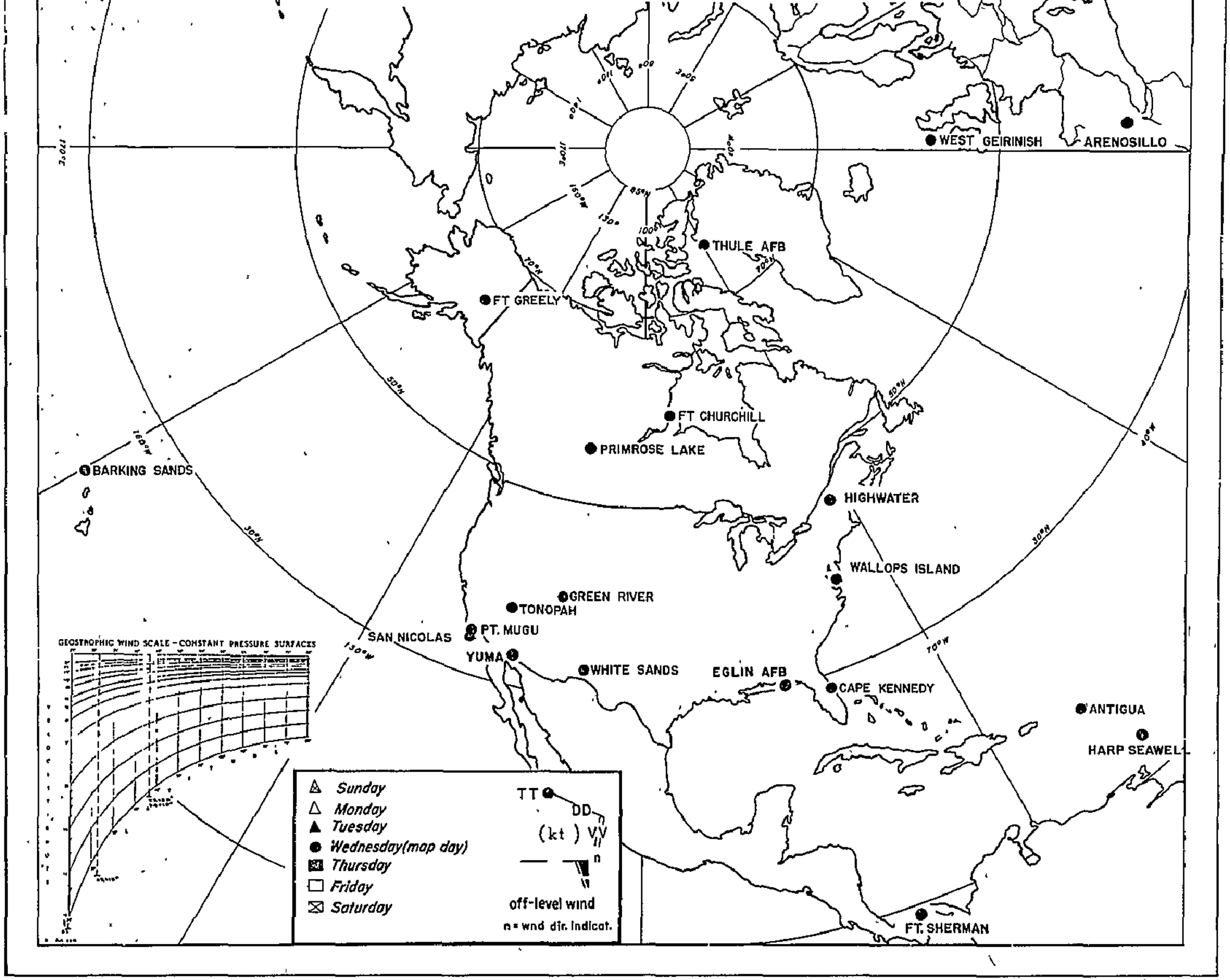
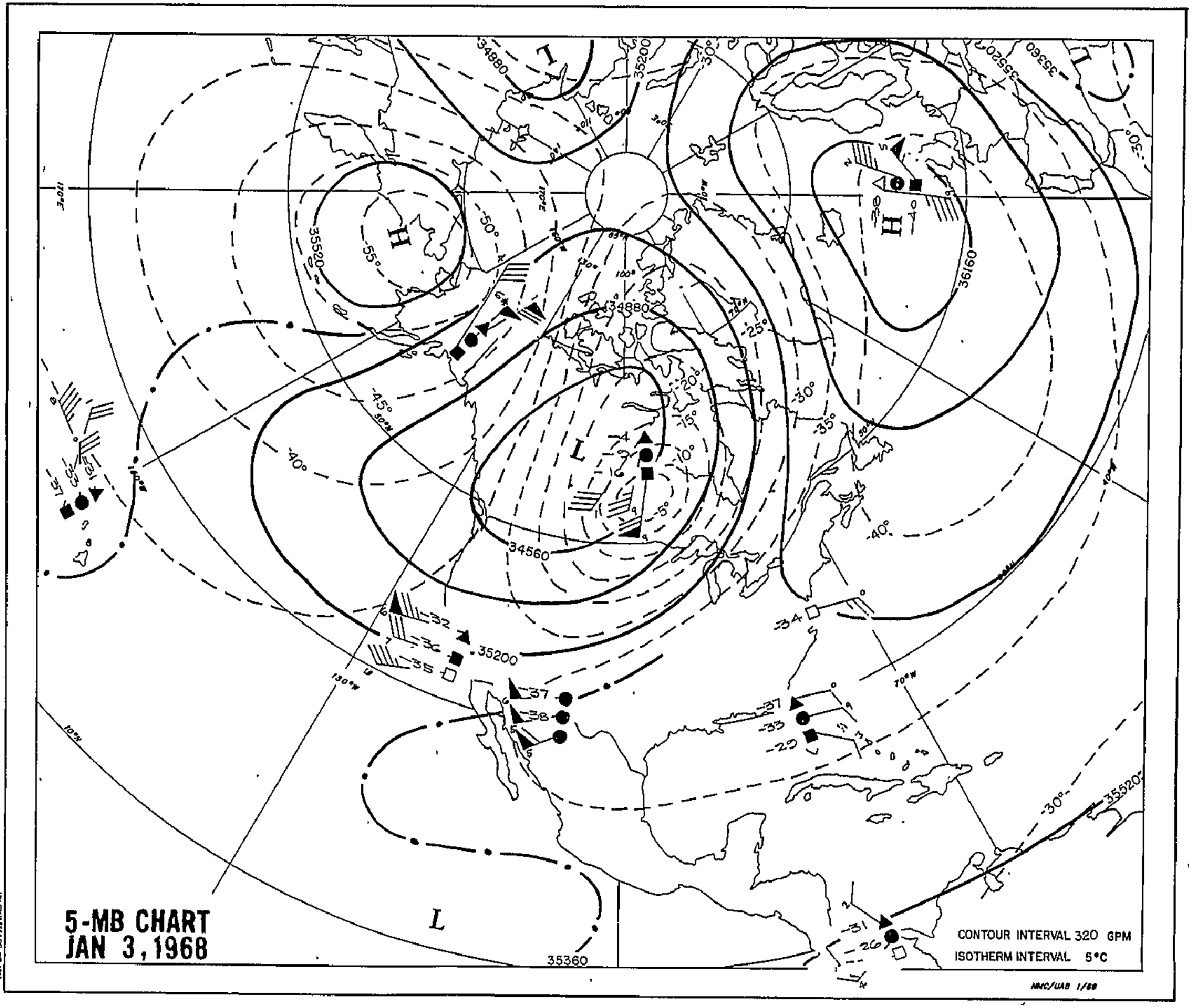


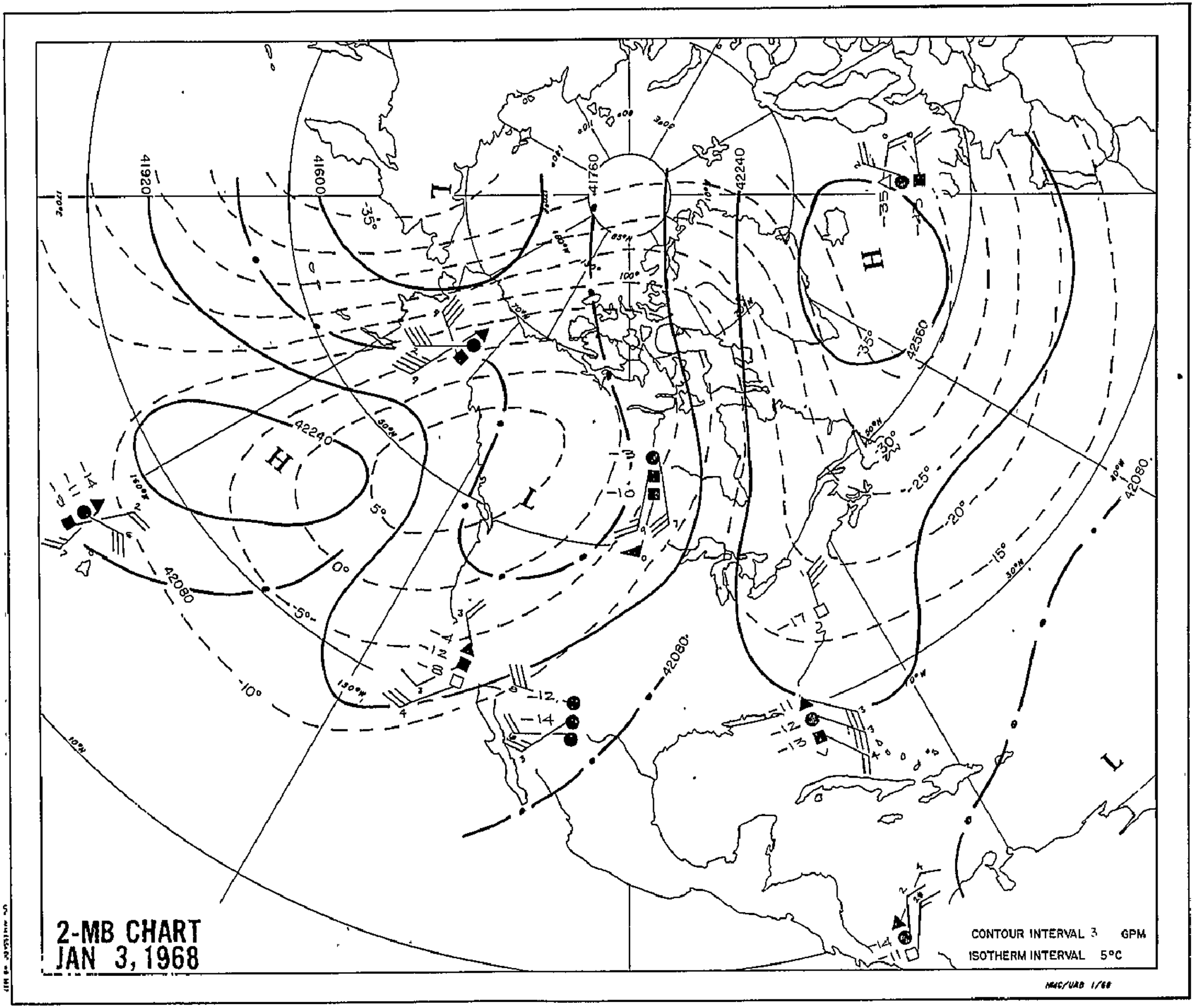
FIGURE 5.—Antigua, W.I.A.S. (17°09′N., 61°47′W.), analyzed values extracted from weekly 5-, 2-, and 0.4-mb charts.

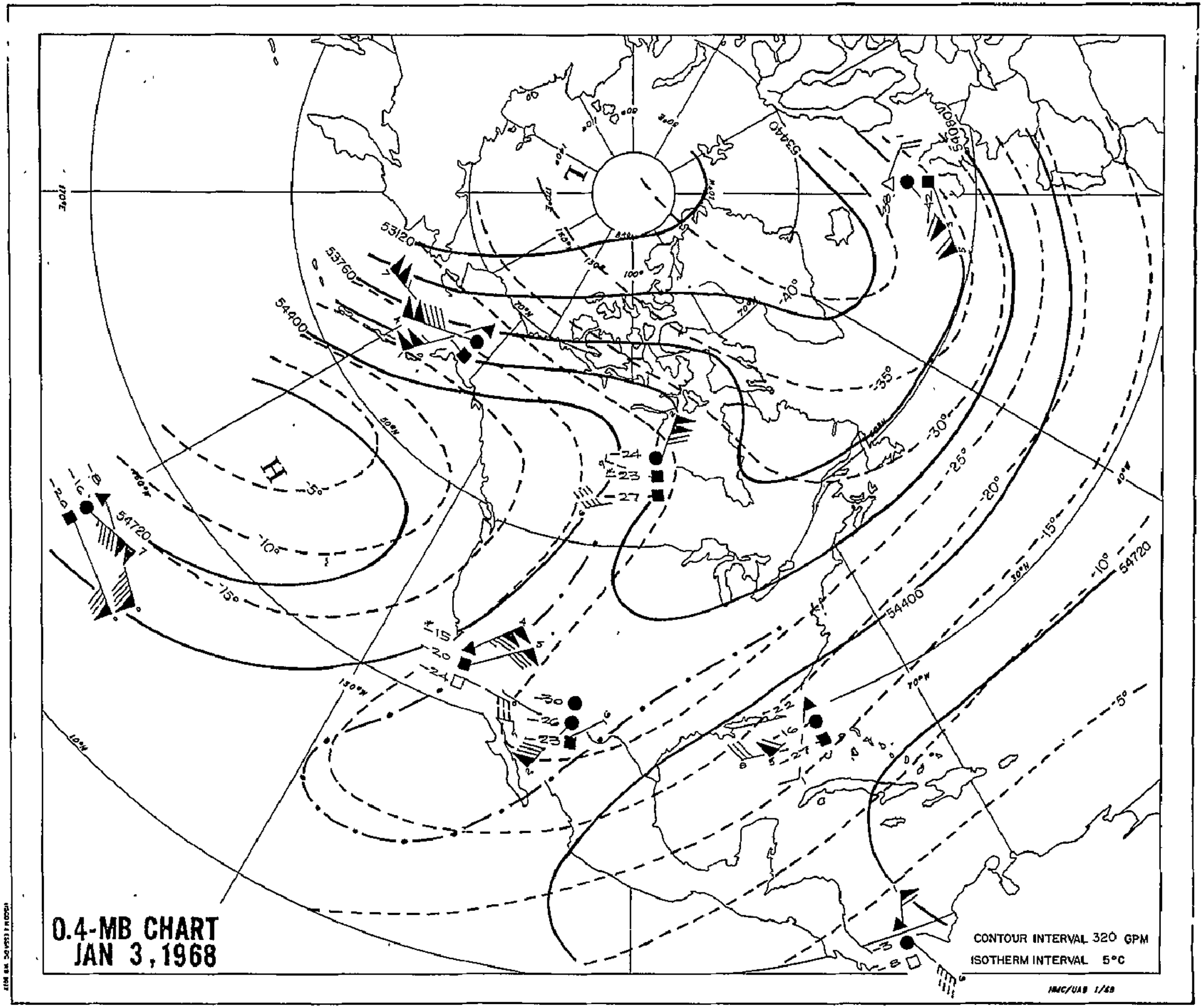
STATION MODEL AND REPORTING ROCKET STATIONS

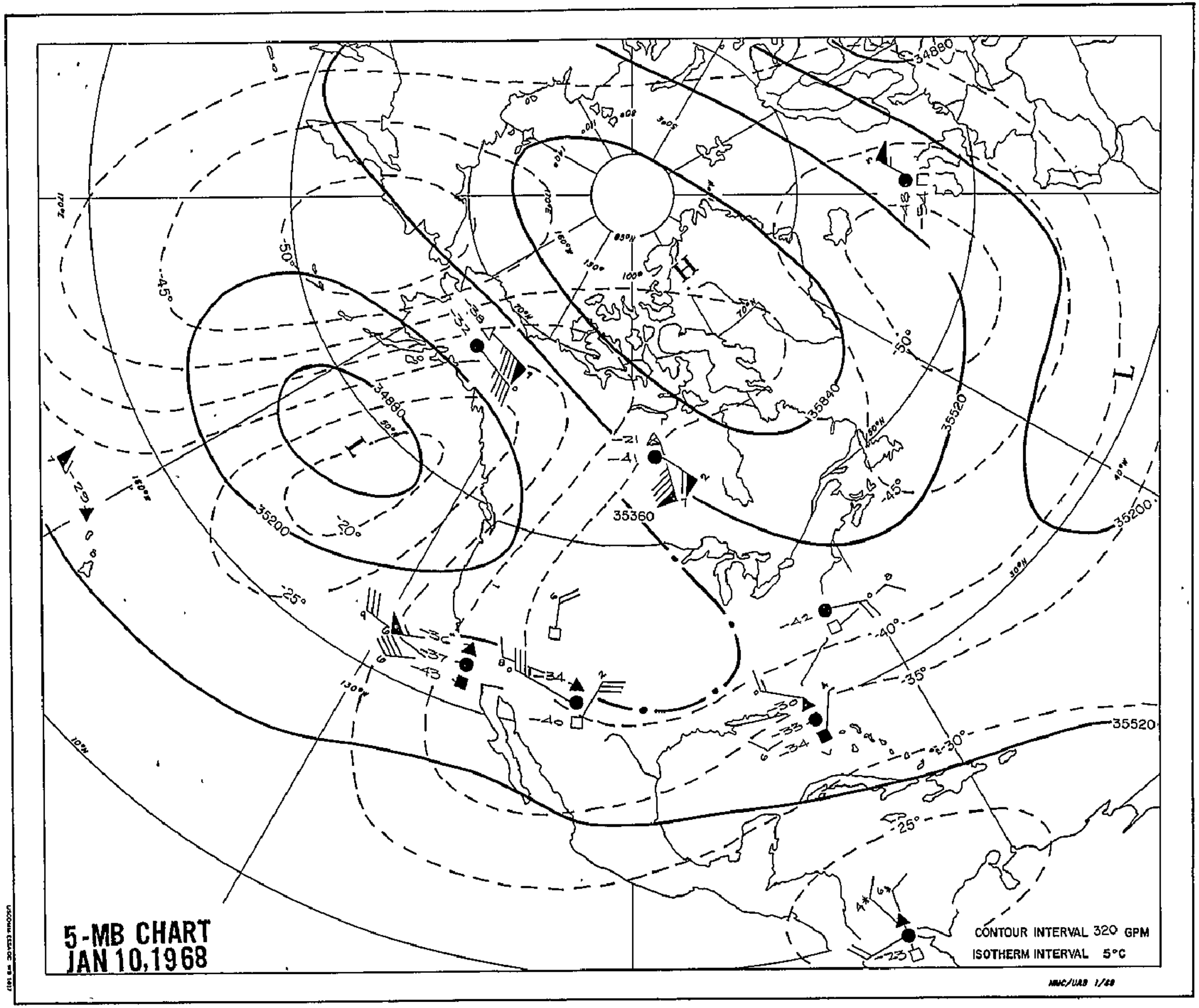


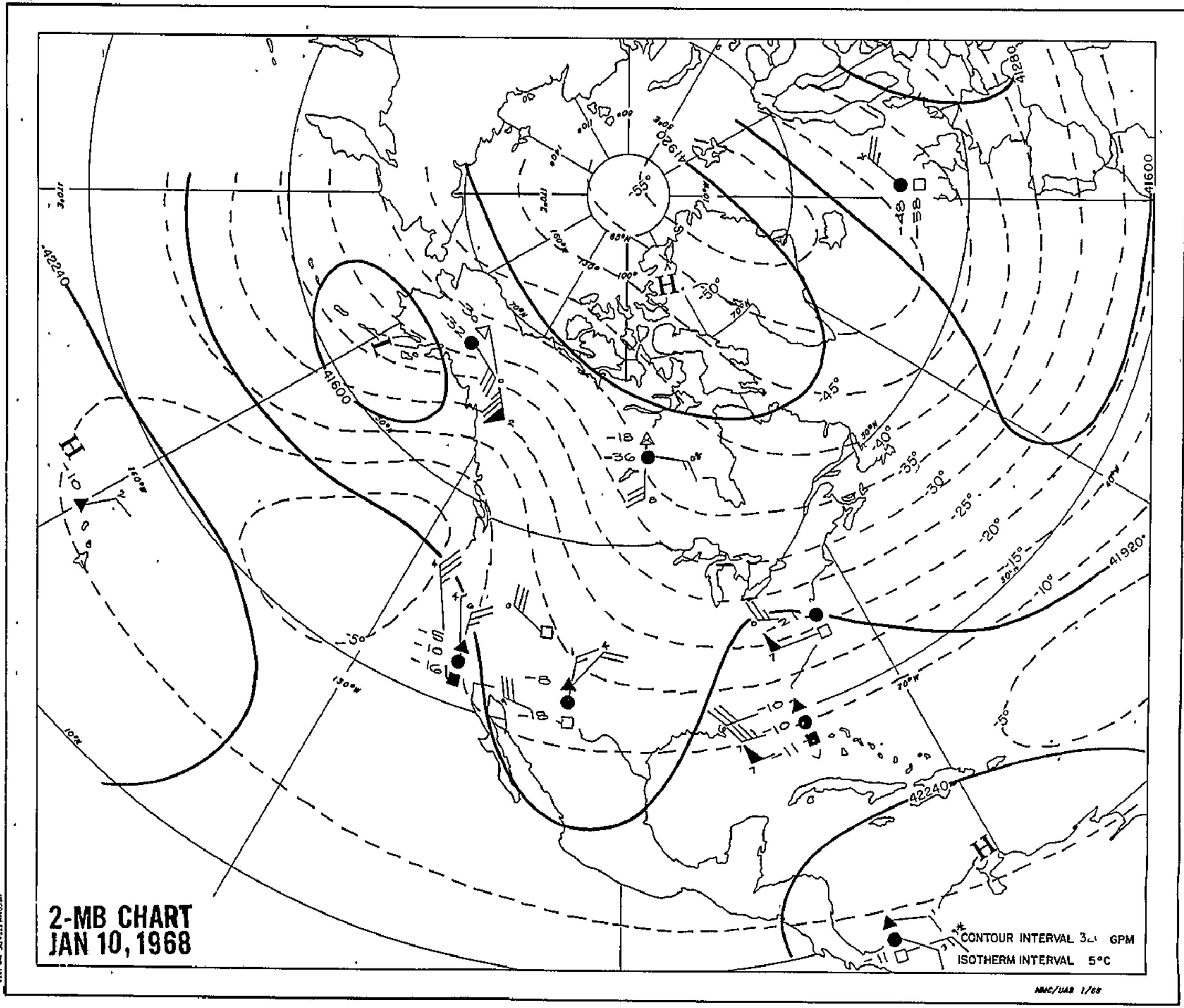
PRECEDING PAGE BLANK NOT FILMED


5-MB CHART
JAN 3,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
L
35200
34880
35520
36160
35360
34560
-50°
-55°
-45°
-40°
-30°
-25°
-20°
-15°
-10°
-5°
-35°

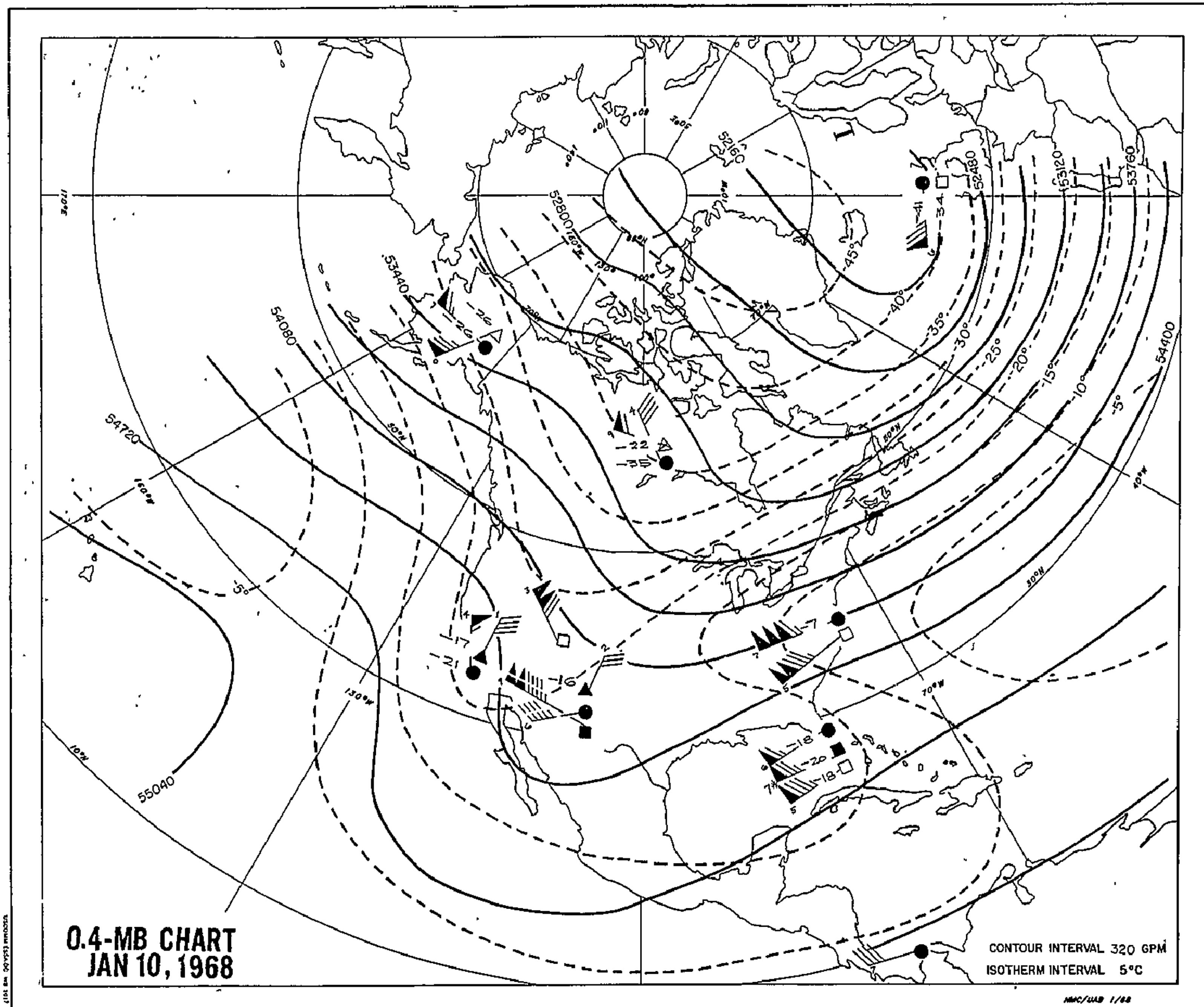

2-MB CHART
JAN 3, 1968
CONTOUR INTERVAL 3 GPM
ISOTHERM INTERVAL 5°C
H
L
41920
41600
41760
42240
42560
42080
-35°
-30°
-25°
-20°
-15°
-10°
-5°
0°
5°

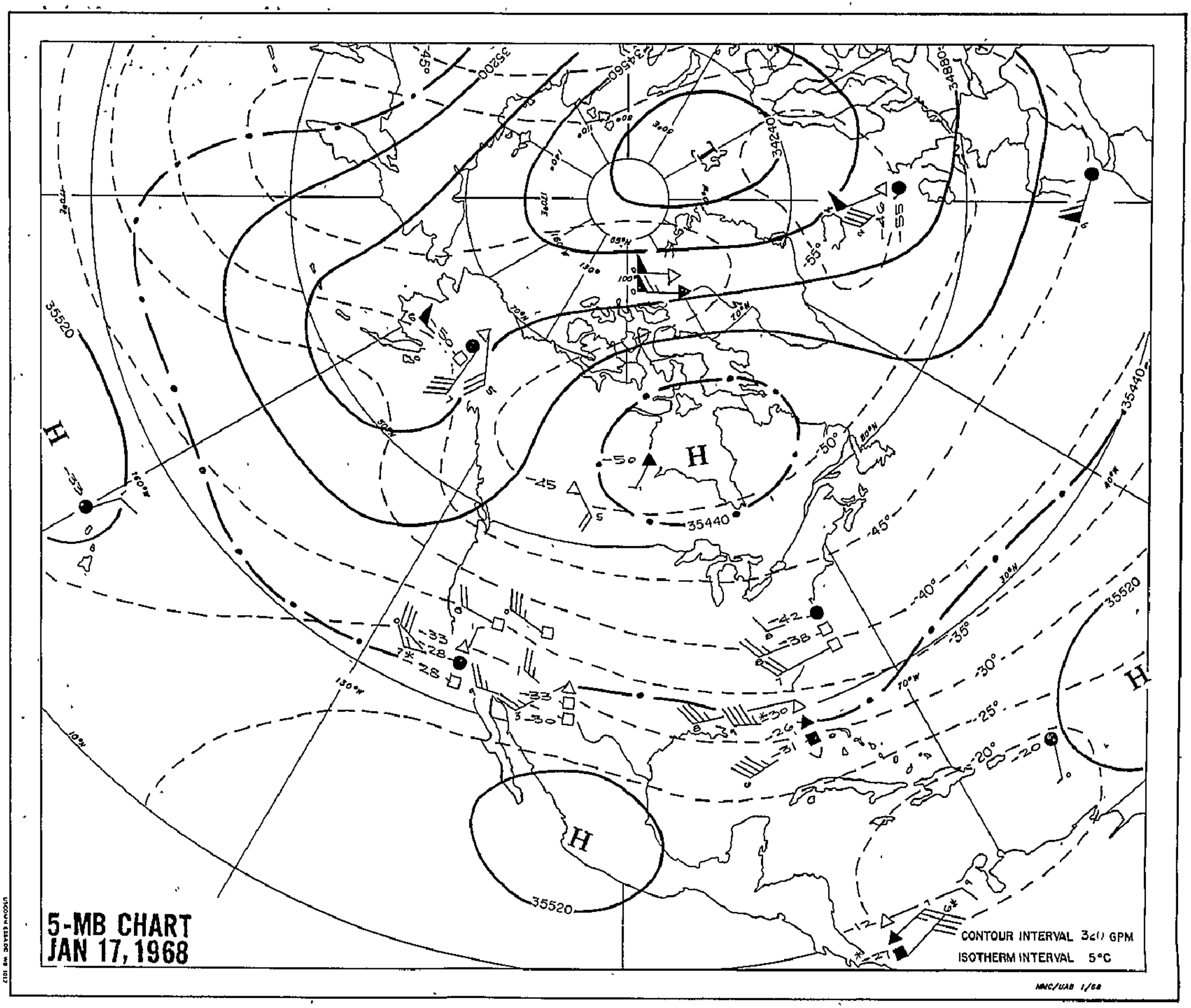

0.4-MB CHART
JAN 3,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
53120
53760
54400
54720
53440
54080
-5°
-10°
-15°
-20°
-25°
-30°
-35°
-40°
H
L

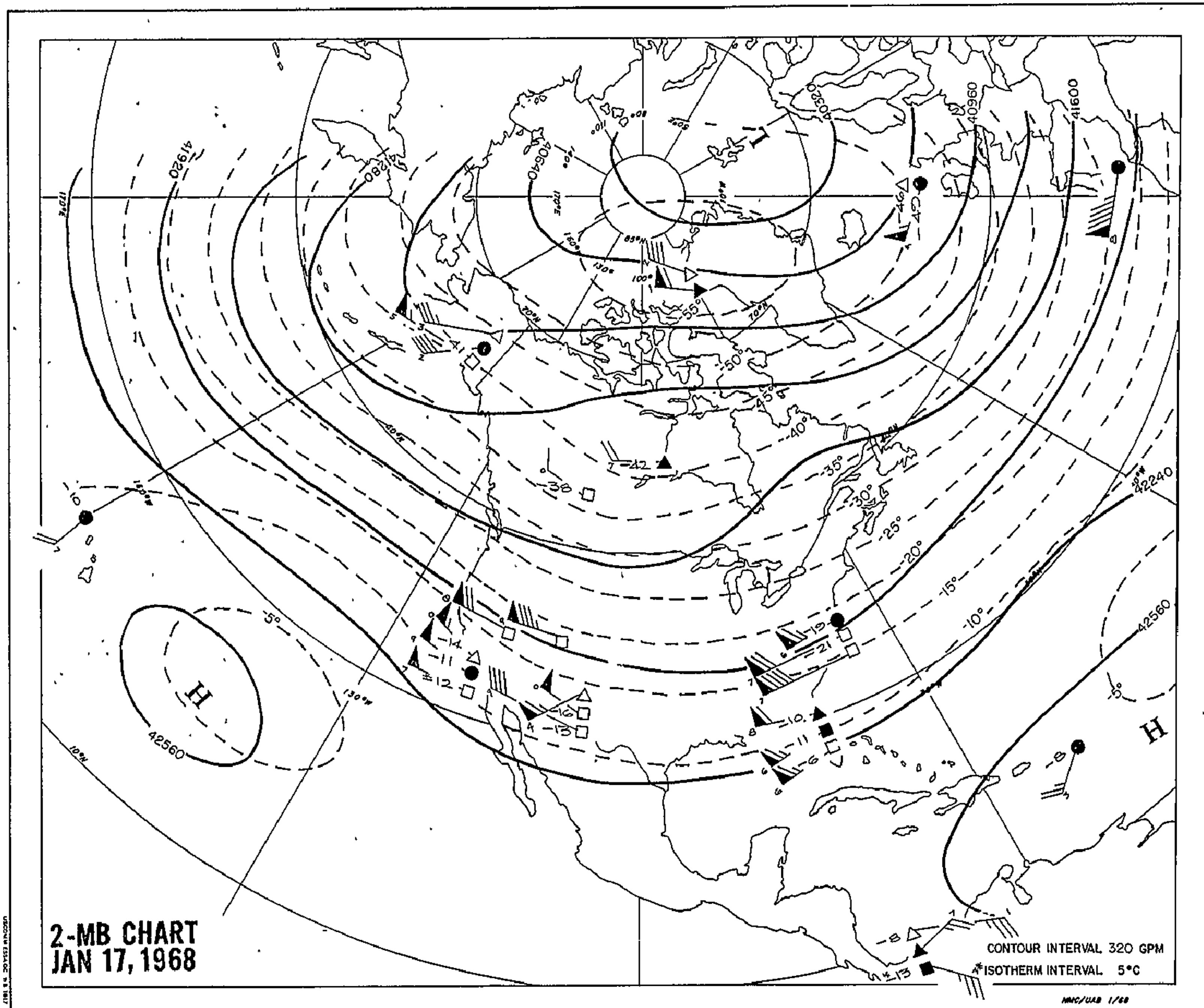

5-MB CHART
JAN 10,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
34880
35200
35360
35520
35840
-50°
-45°
-40°
-35°
-30°
-25°
-20°
H
L
NMC/UAB 1/68

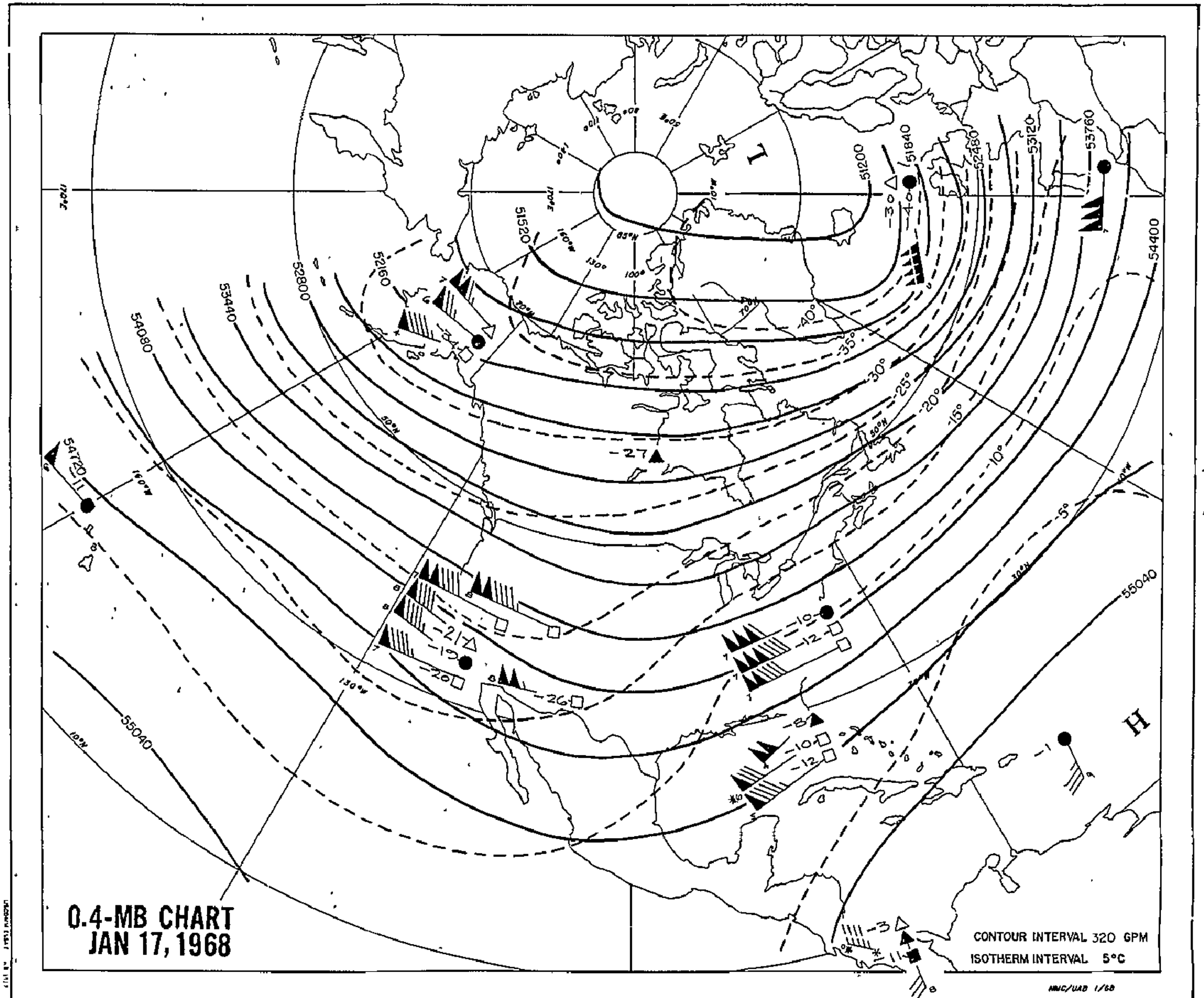


2-MB CHART
JAN 10, 1968

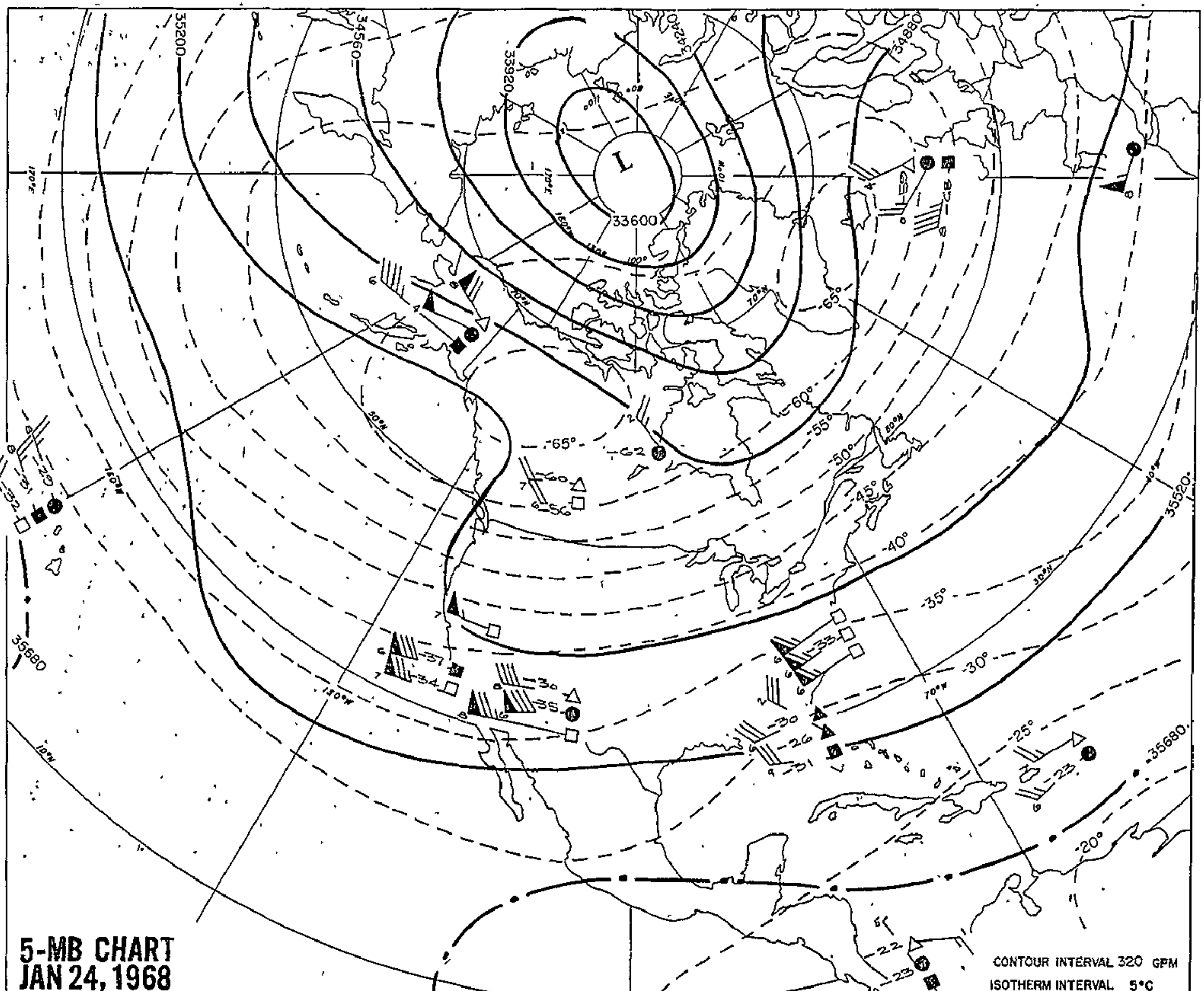

0.4-MB CHART
JAN 10, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
52160
52480
52800
53120
53440
53760
54080
54400
54720
55040
-45°
-40°
-35°
-30°
-25°
-20°
-15°
-10°
-5°
-5°
L
NMC/UAB 1/68


5-MB CHART
JAN 17, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
NMC/UAB 1/68
35520
35440
35200
34880
34560
34240
H
L
-45°
-50°
-55°
-40°
-35°
-30°
-25°
-20°

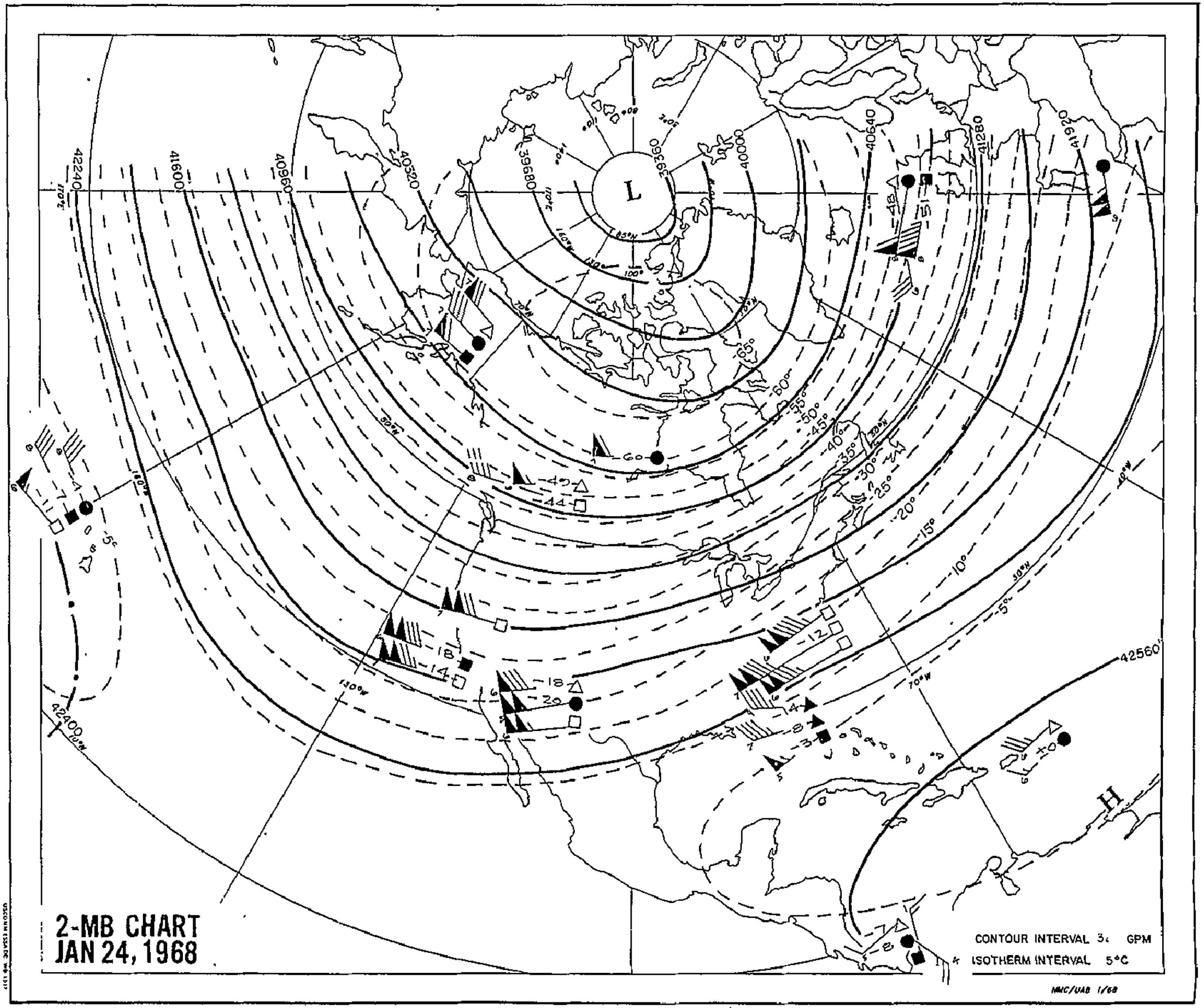

2-MB CHART
JAN 17, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
H
L
42560
42240
41920
41600
41280
40960
40640
40320
-55°
-50°
-45°
-40°
-35°
-30°
-25°
-20°
-15°
-10°
-5°

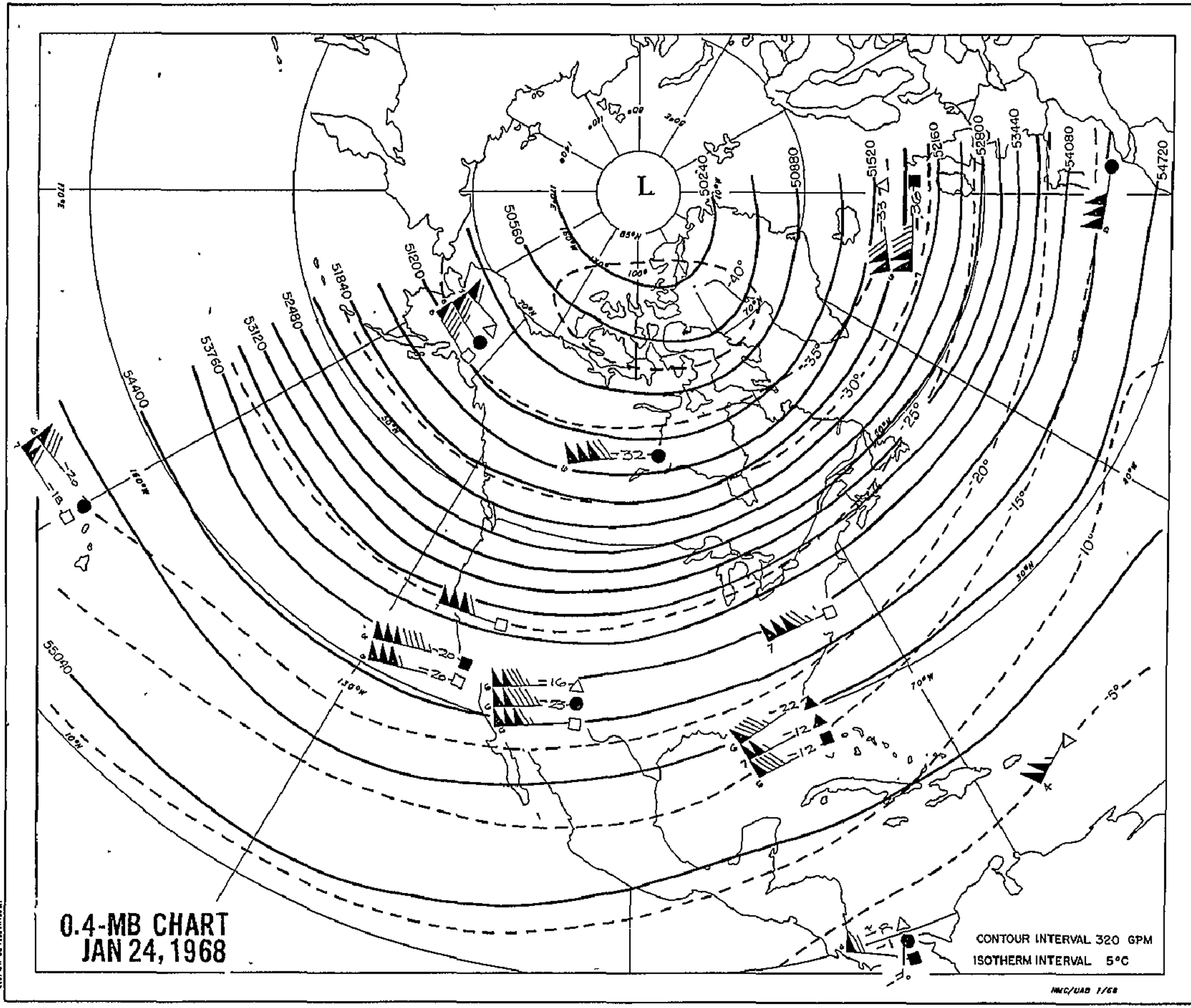


0.4-MB CHART
JAN 17, 1968

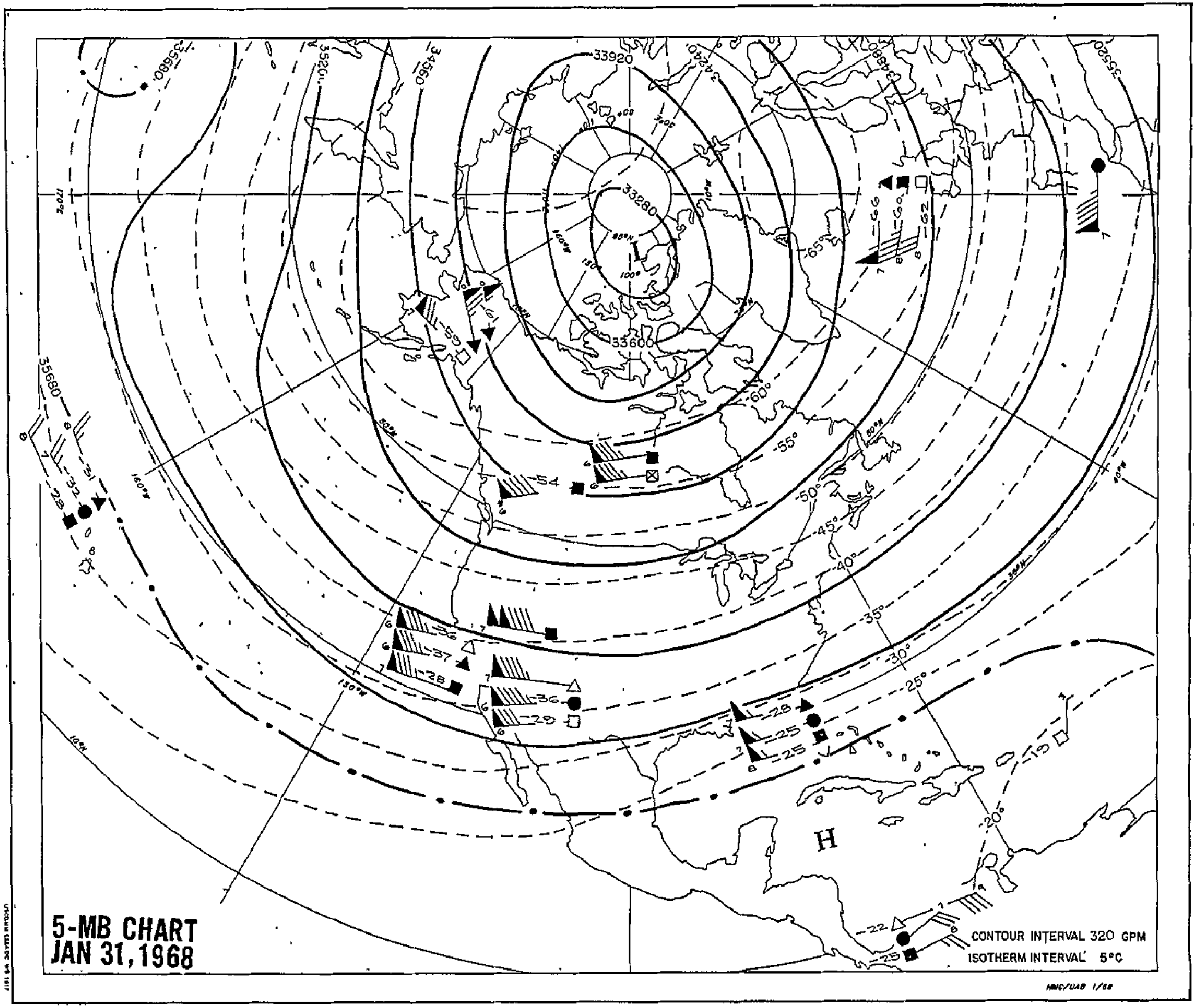


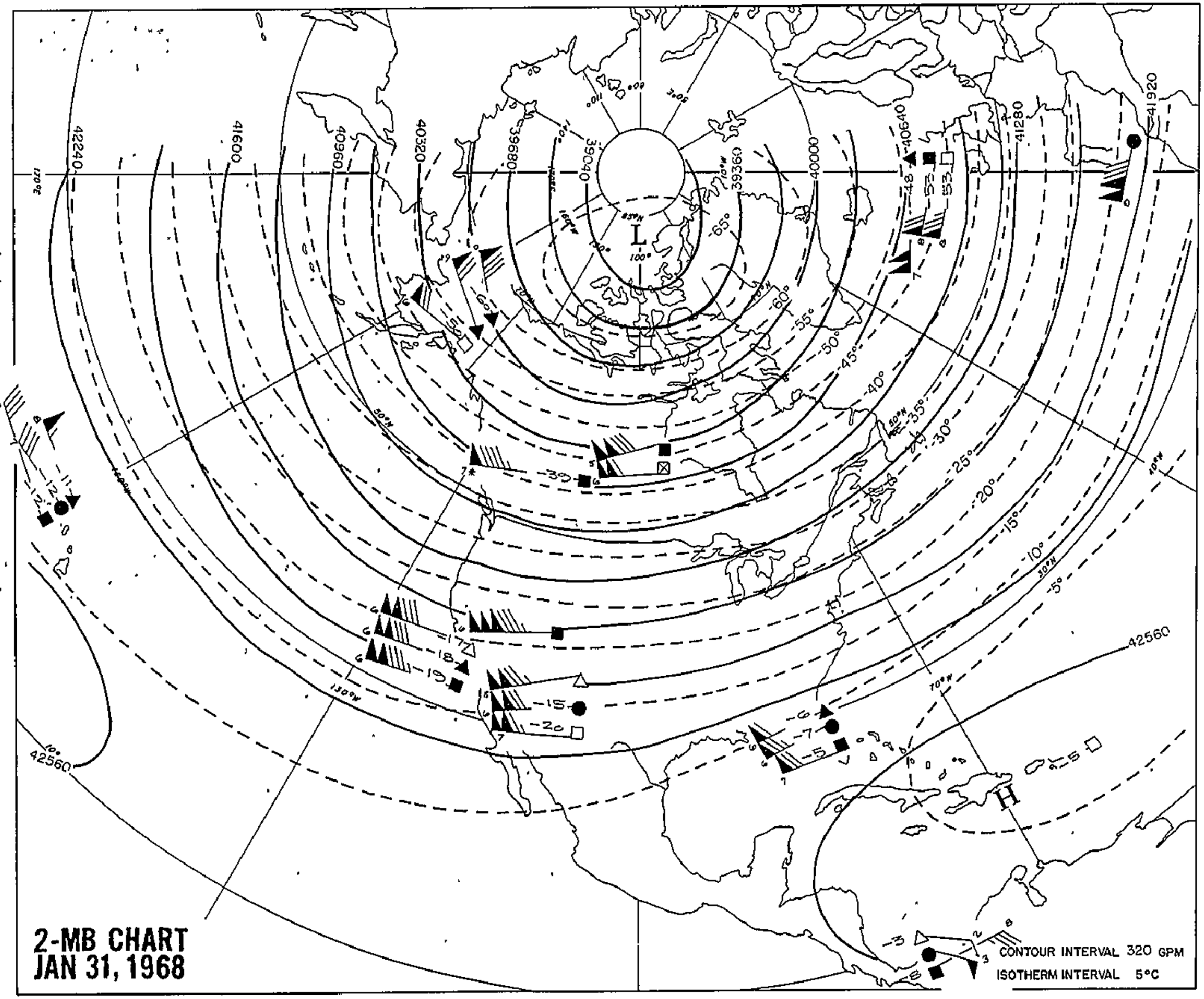
5-MB CHART
JAN 24, 1968


2-MB CHART
JAN 24, 1968
CONTOUR INTERVAL
GPM
ISOTHERM INTERVAL 5°C
L
H
42240
41600
41910
40960
40604
40320
39680
39360
40000
40640
41280
41920
42560
42400
-65°
-60°
-55°
-50°
-45°
-40°
-35°
-30°
-25°
-20°
-15°
-10°
-5°
NMC/UAB 1/68

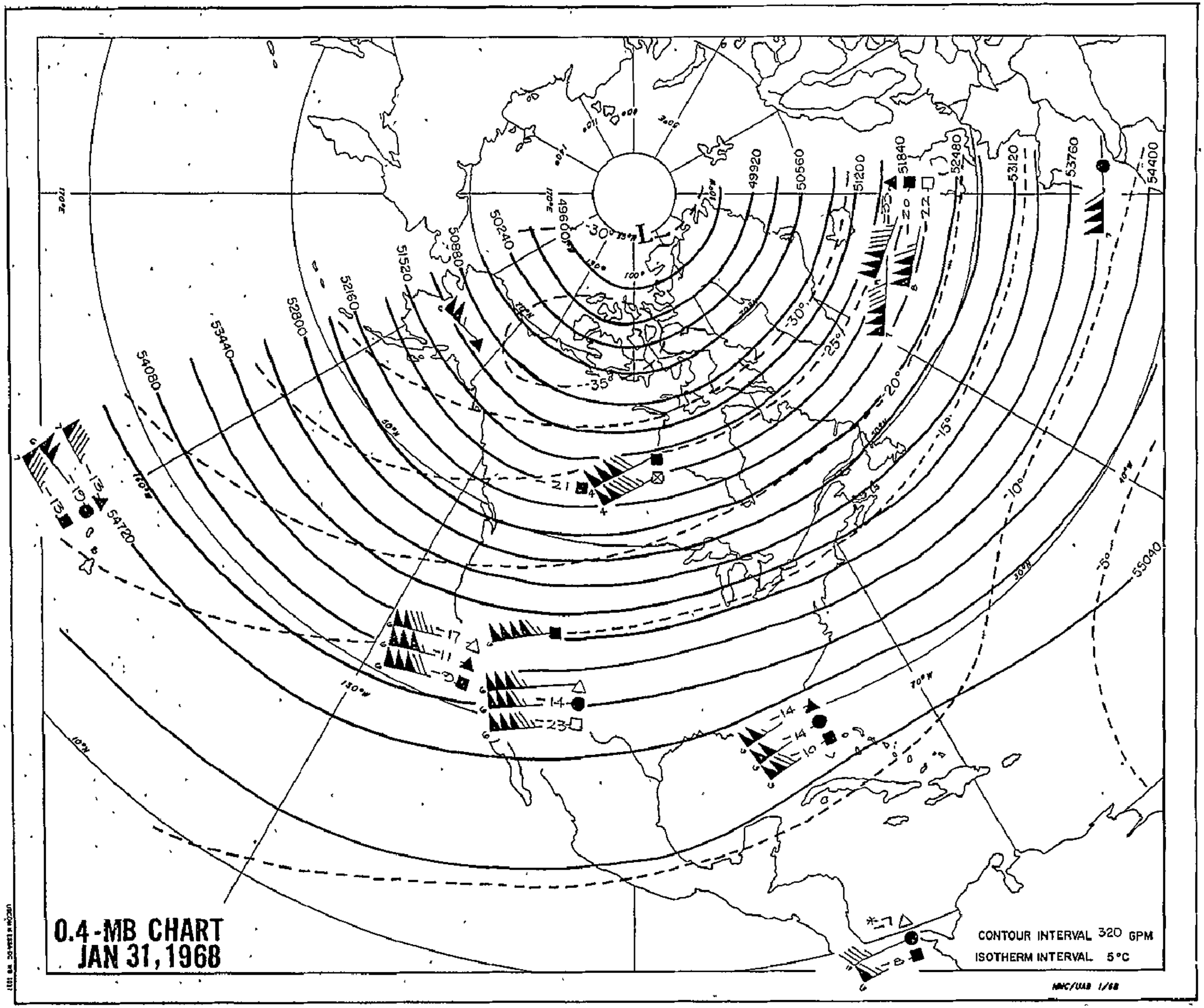


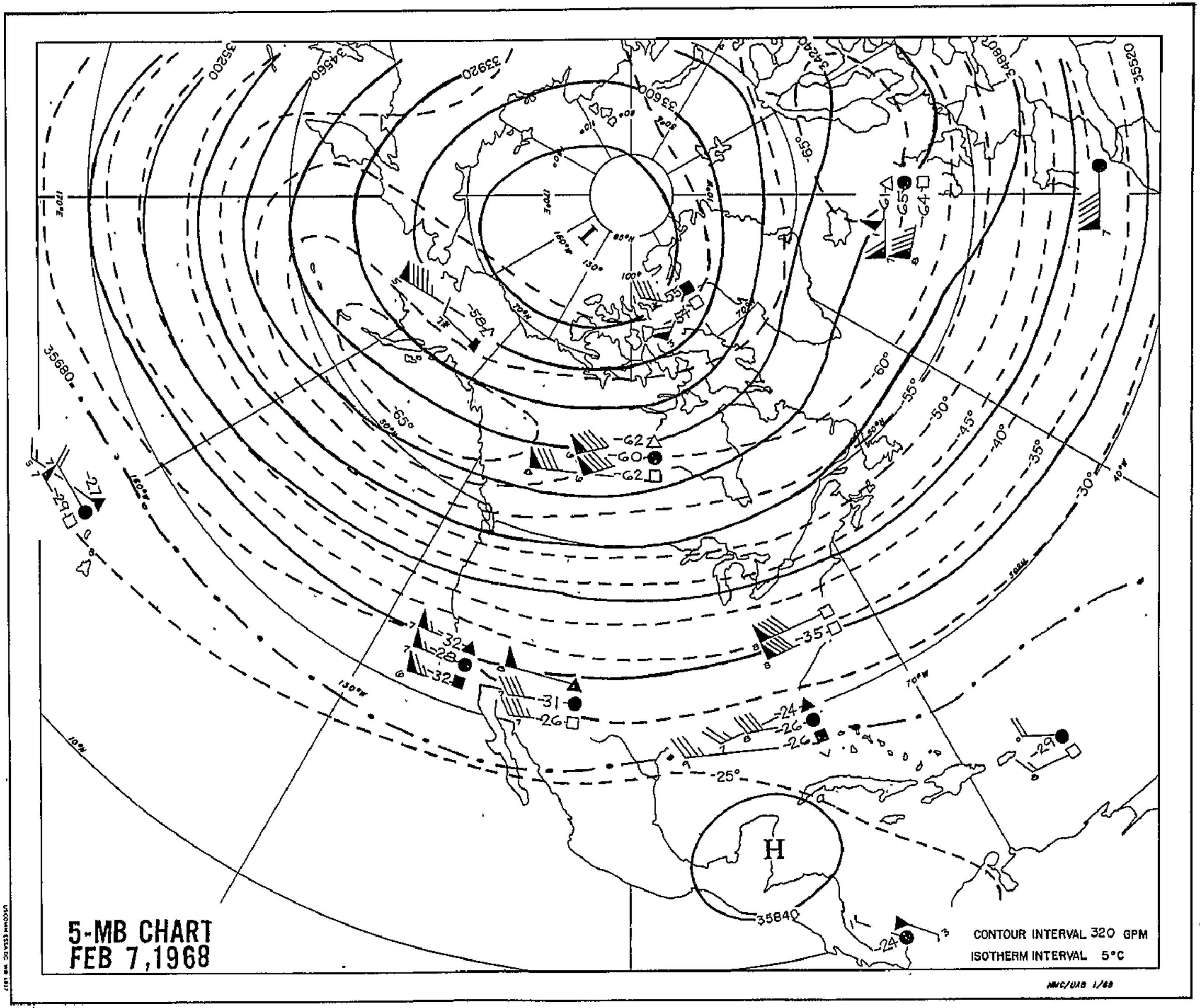
0.4-MB CHART
JAN 24, 1968

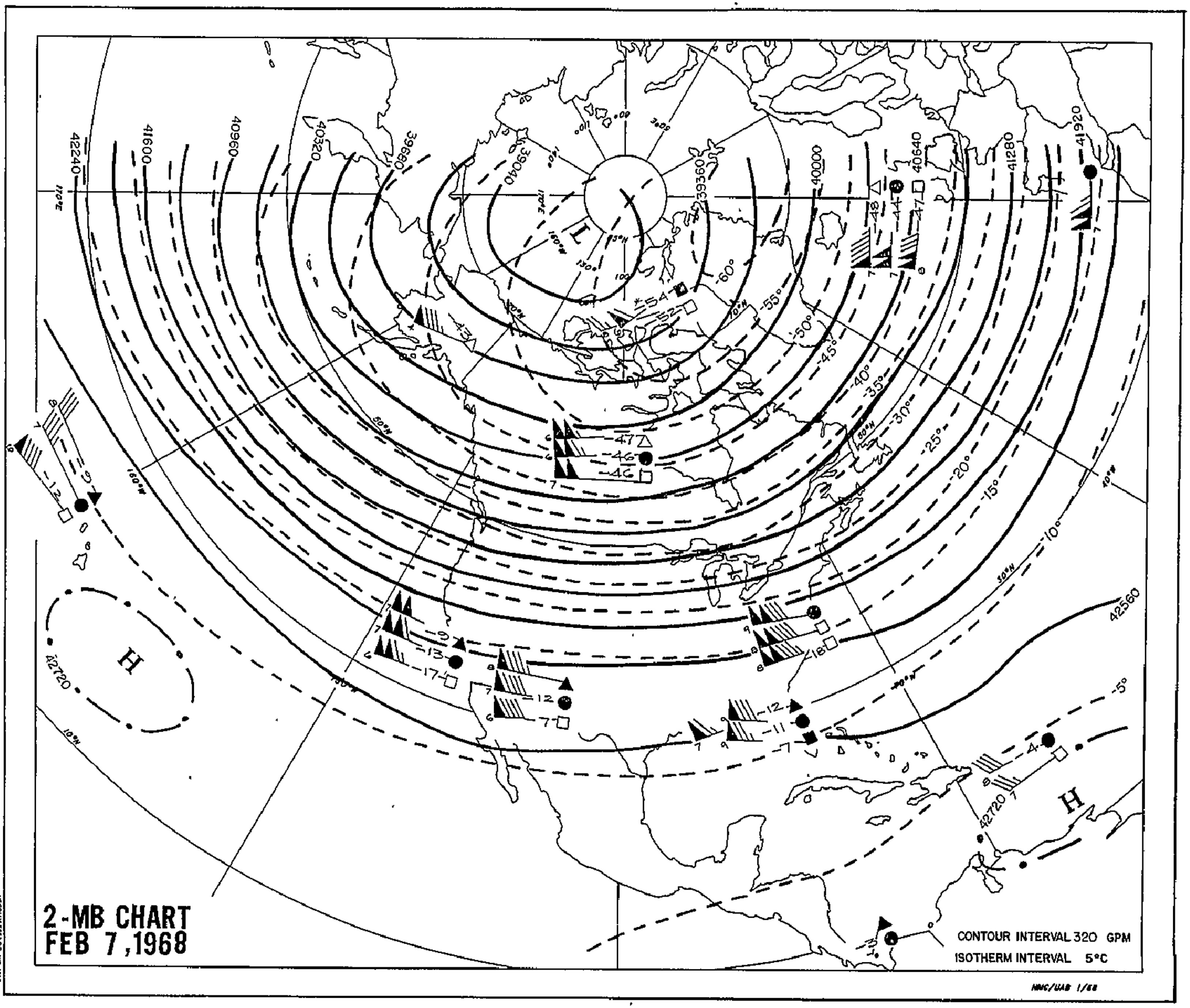

5-MB CHART
JAN 31,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
33920
33600
33280
34240
34560
34880
35200
35520
35680
L
H
-65°
-60°
-55°
-50°
-45°
-40°
-35°
-30°
-25°
-20°
-15°

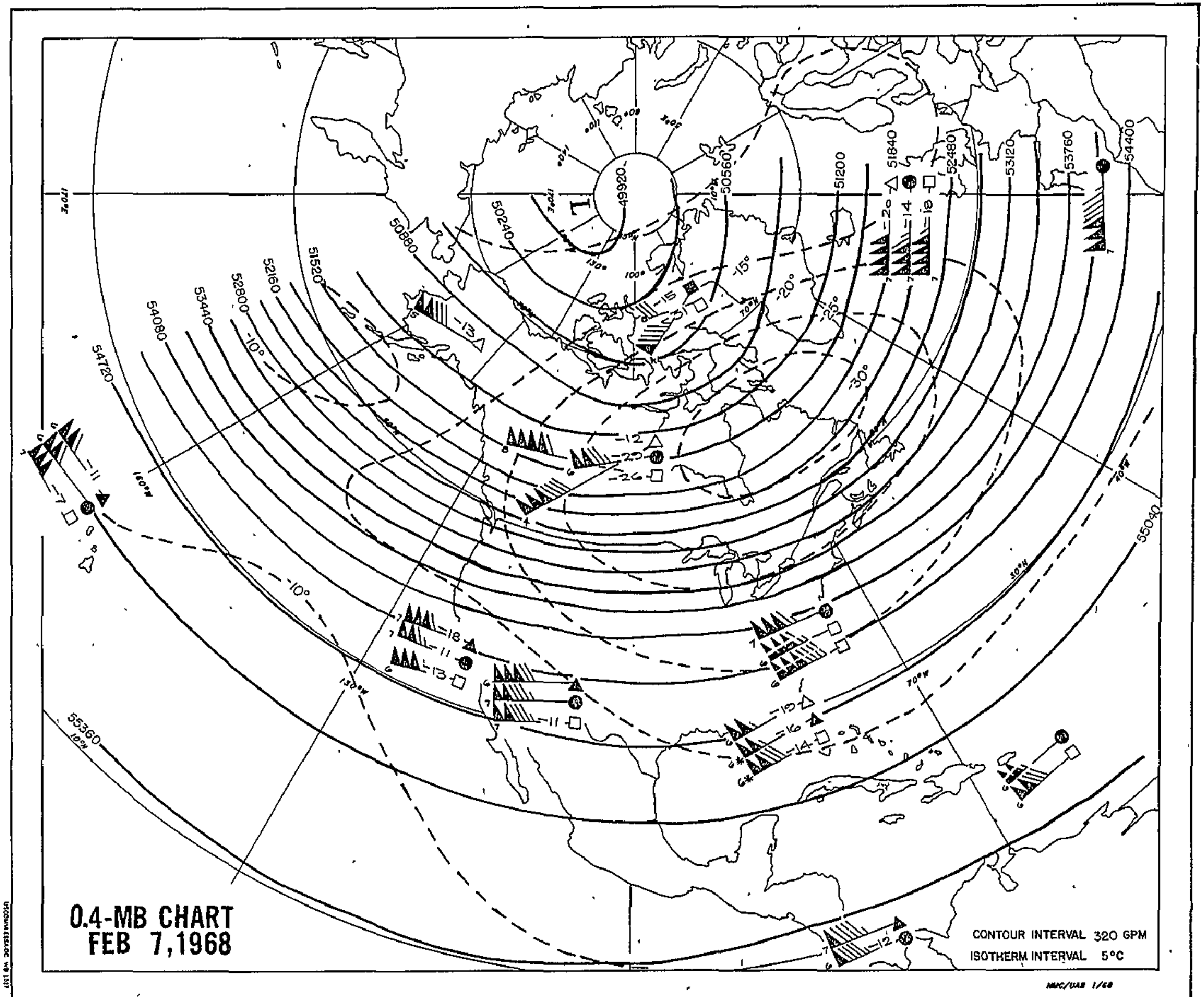


2-MB CHART
JAN 31, 1968

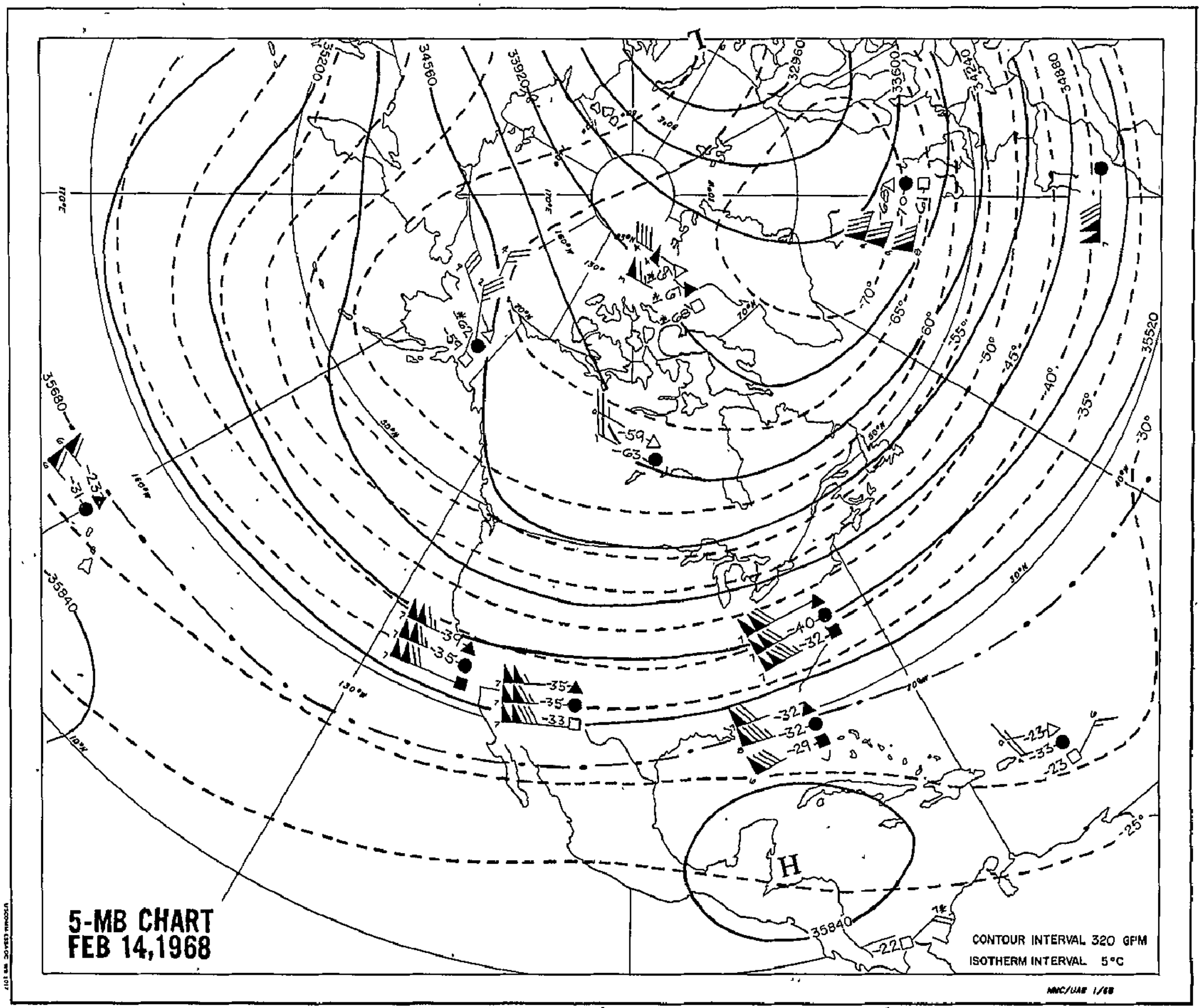

0.4-MB CHART
JAN 31, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
49600
49920
50240
50560
50880
51200
51520
51840
52160
52480
52800
53120
53440
53760
54080
54400
54720
55040
L
-30°
-35°
-25°
-20°
-15°
-10°
-5°
130°W
70°W
10°N
30°N
50°N

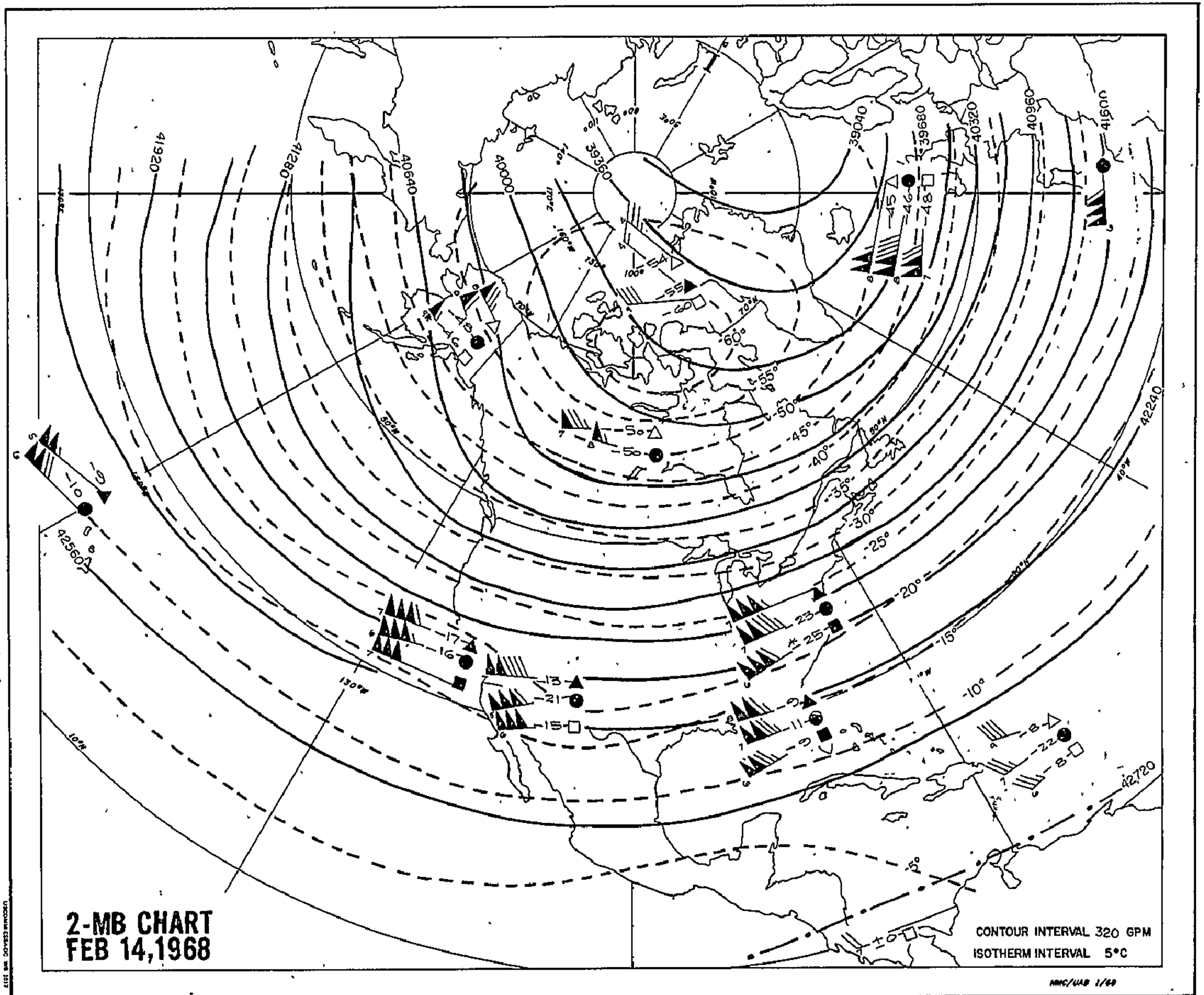

5-MB CHART
FEB 7,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
35840
35680
35520
35200
34560
33920
33600
34240
34880
H
-60°
-55°
-50°
-45°
-40°
-35°
-30°
-25°
-65°

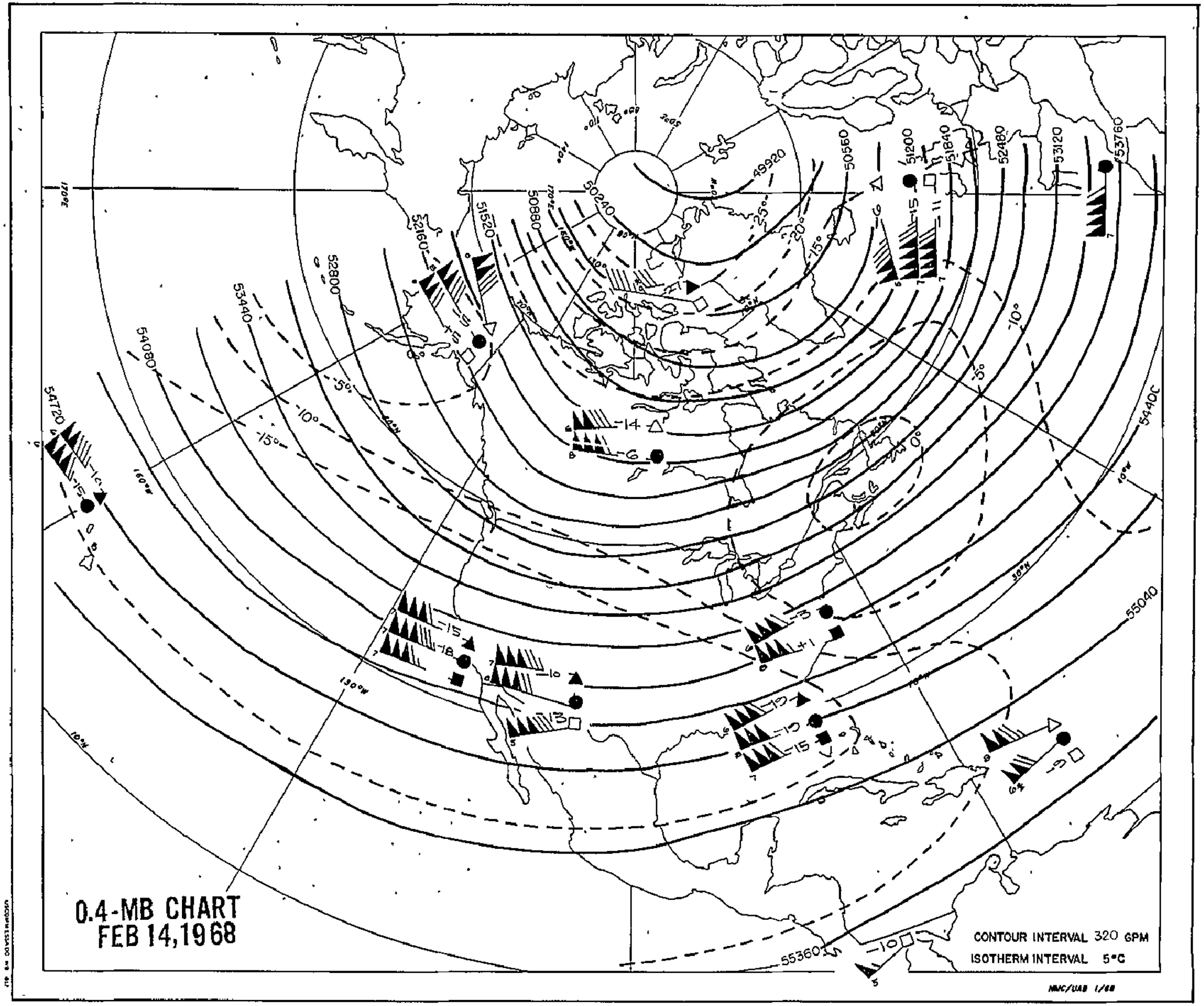

2-MB CHART
FEB 7,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
42240
41600
40960
40320
39680
39040
39360
40000
40640
41280
41920
42560
42720

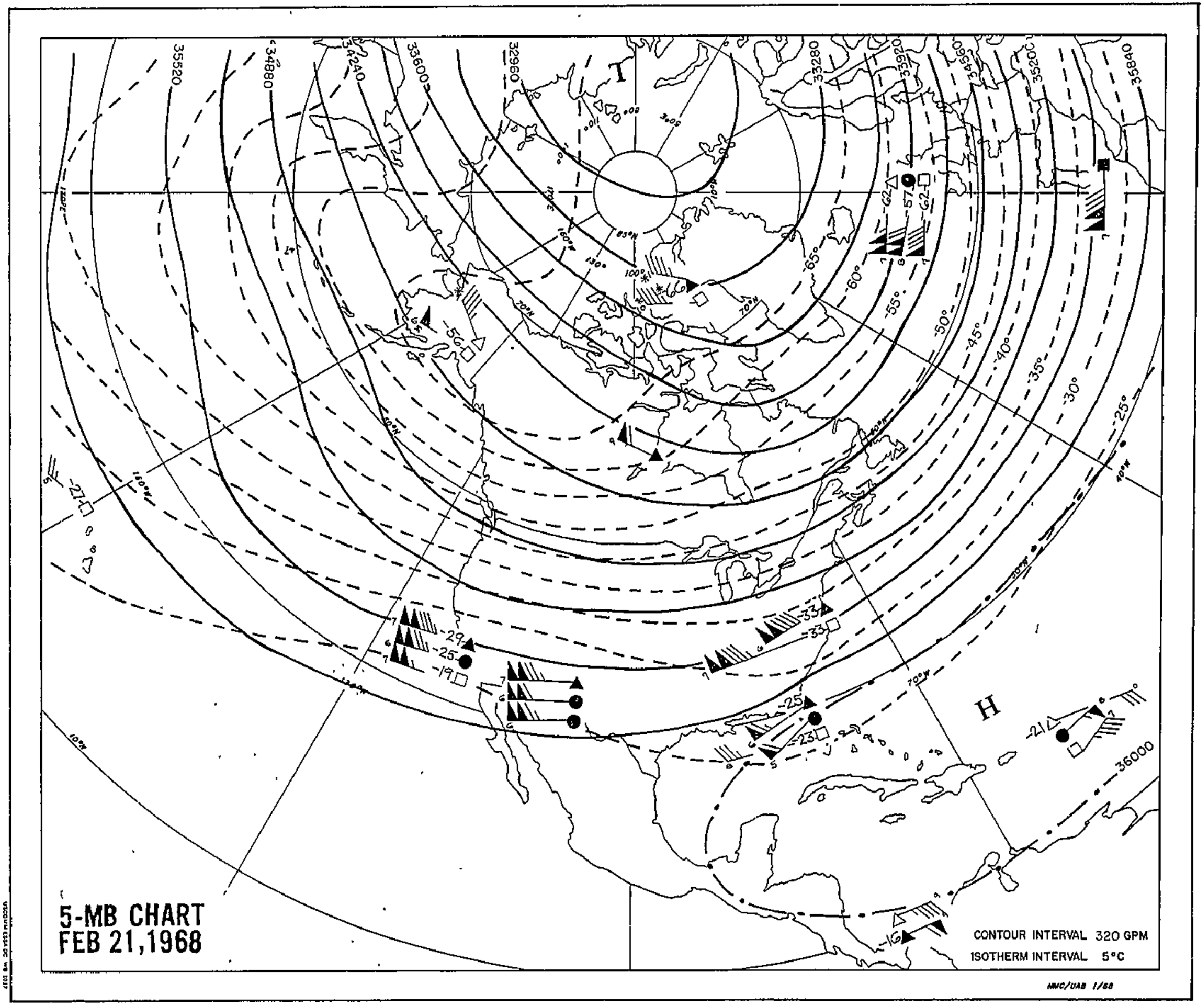


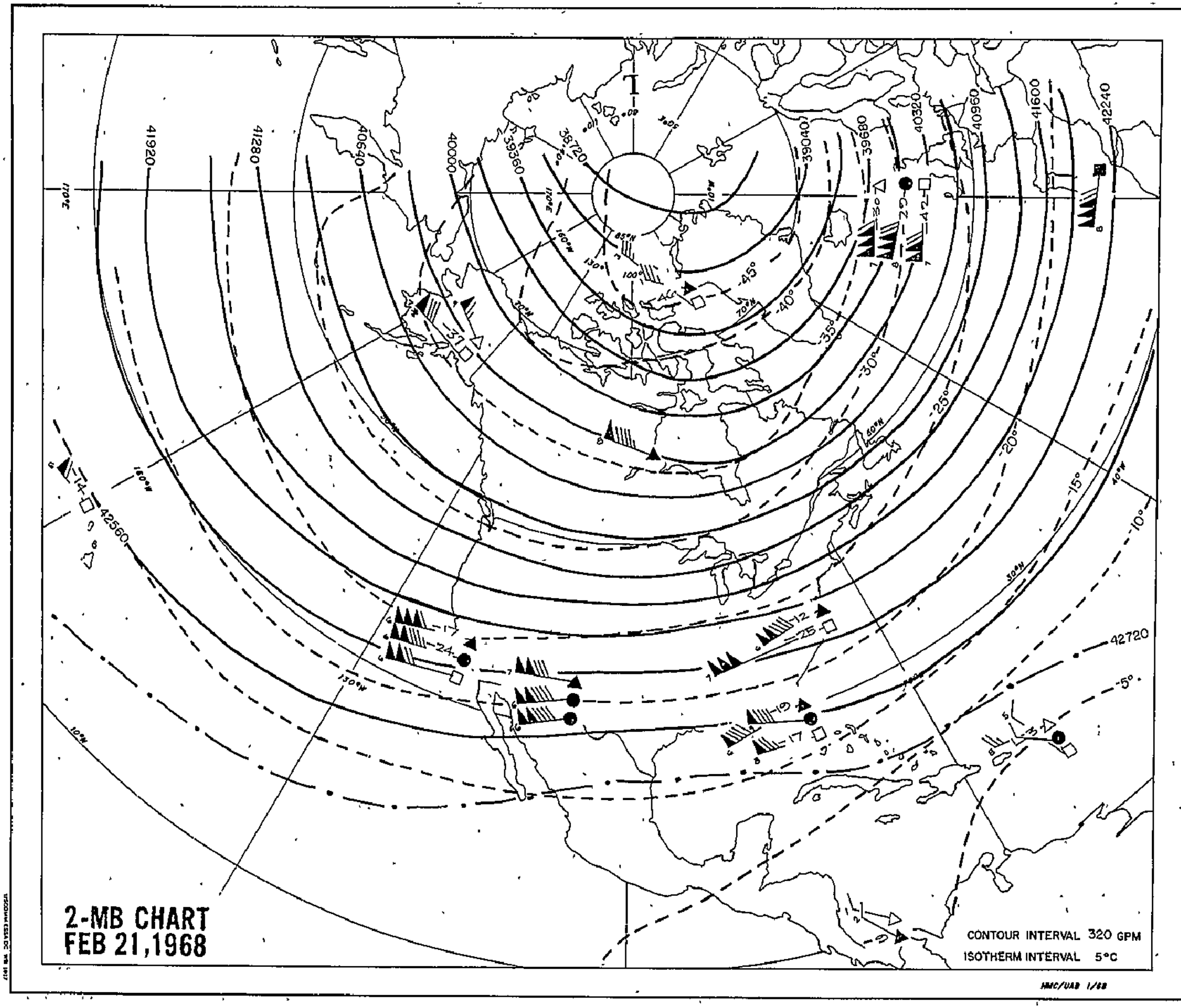
0.4-MB CHART
FEB 7,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
49920
50240
50560
50880
51200
51520
51840
52160
52480
52800
53120
53440
53760
54080
54400
54720
55040
55360
-10°
-15°
-20°
-25°
-30°
L

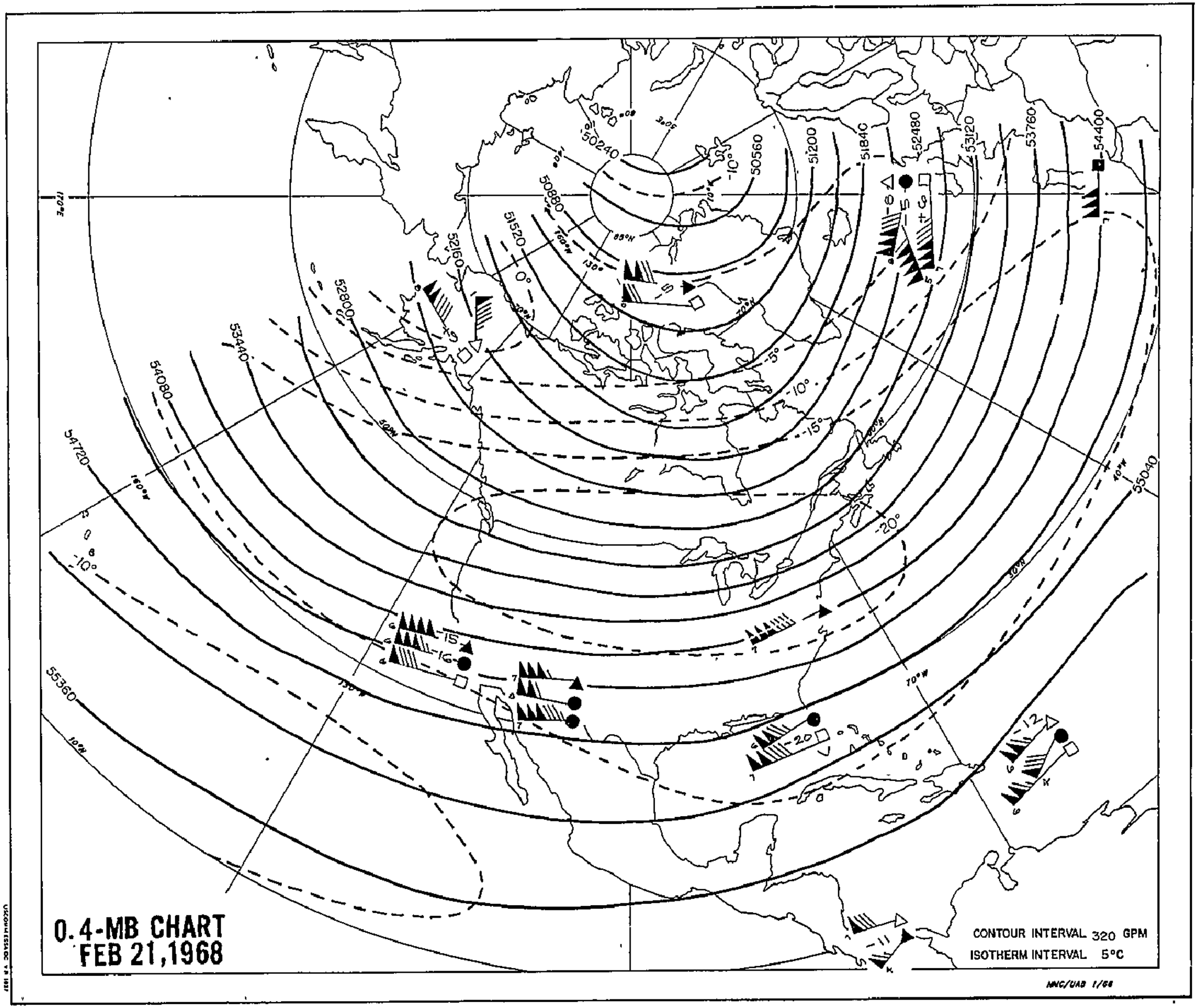

5-MB CHART
FEB 14,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
35840
35680
35520
35200
34880
34560
34240
33920
33600
32960
H
L
-70°
-65°
-60°
-55°
-50°
-45°
-40°
-35°
-30°
-25°
NMC/UAB 1/68

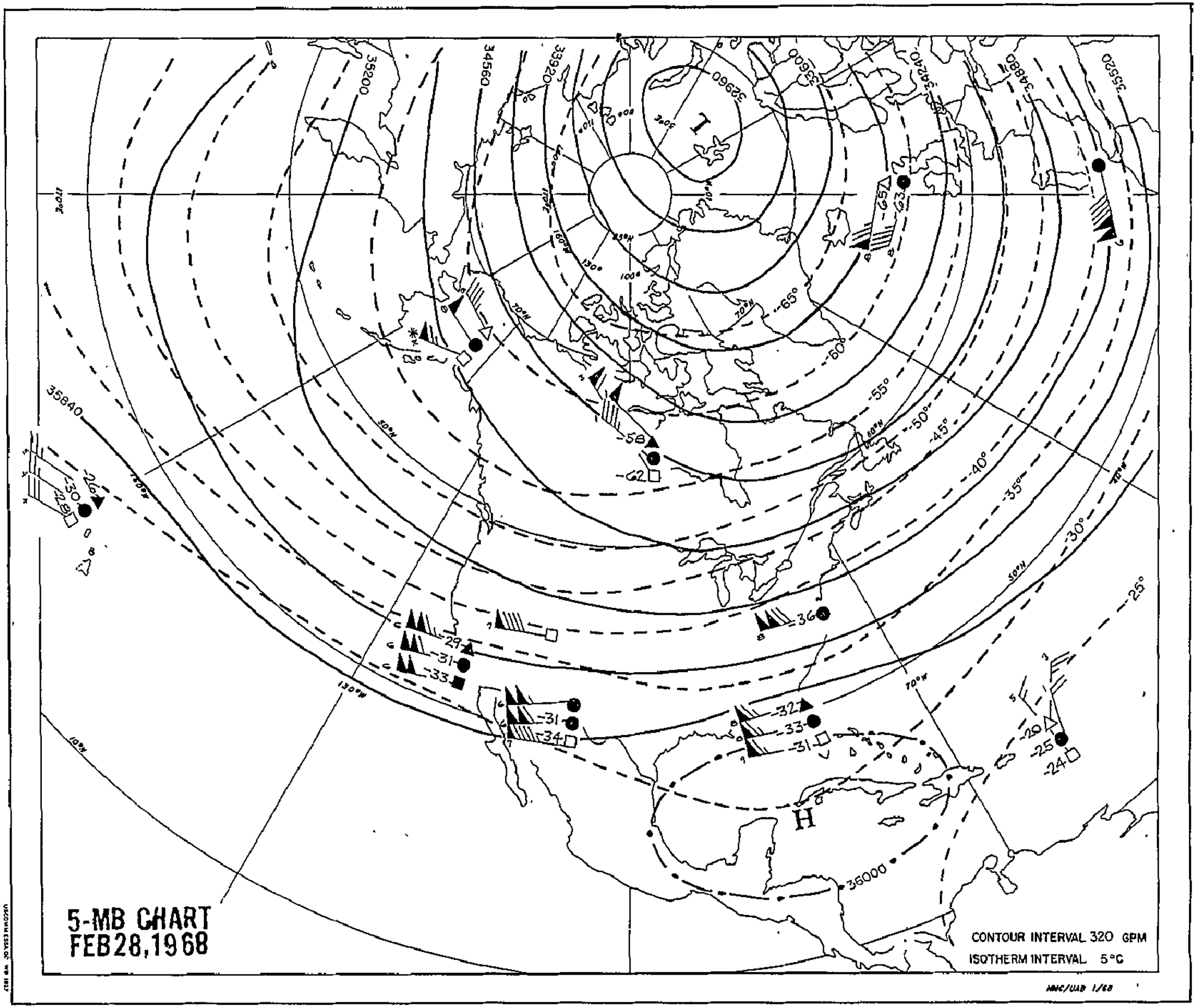

2-MB CHART
FEB 14,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C

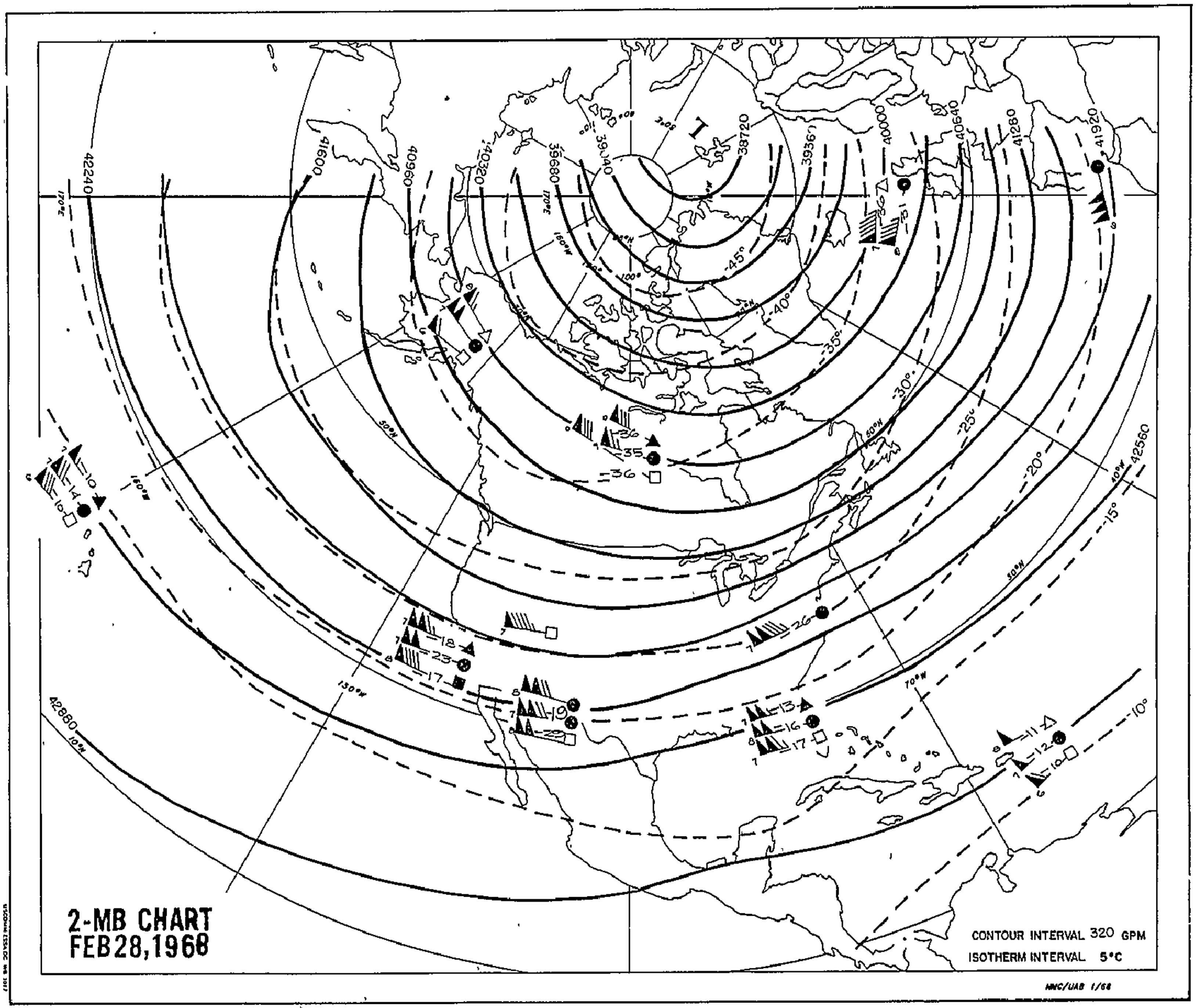

0.4-MB CHART
FEB 14,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
49920
50240
50560
50880
51200
51520
51840
52160
52480
52800
53120
53440
53760
54080
54400
54720
55040
55360


5-MB CHART
FEB 21,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
NMC/UAB 1/68
35520
34880
34240
33600
32960
33280
33920
34560
35200
35840
36000
-65°
-60°
-55°
-50°
-45°
-40°
-35°
-30°
-25°
H

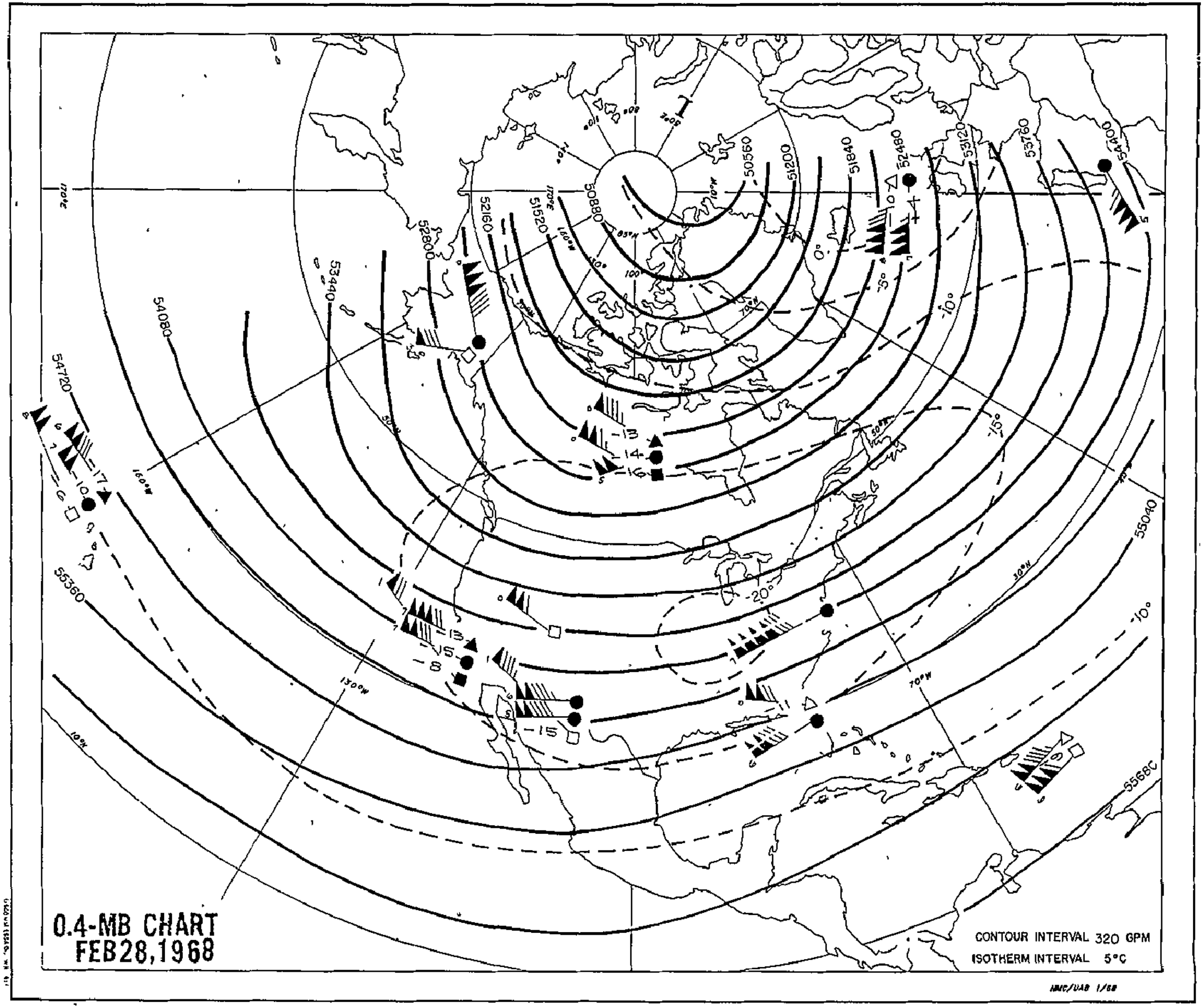

2-MB CHART
FEB 21,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
41920
41280
40640
40000
39360
38720
39040
39680
40320
40960
41600
42240
42560
42720
-45°
-40°
-35°
-30°
-25°
-20°
-15°
-10°
-5°

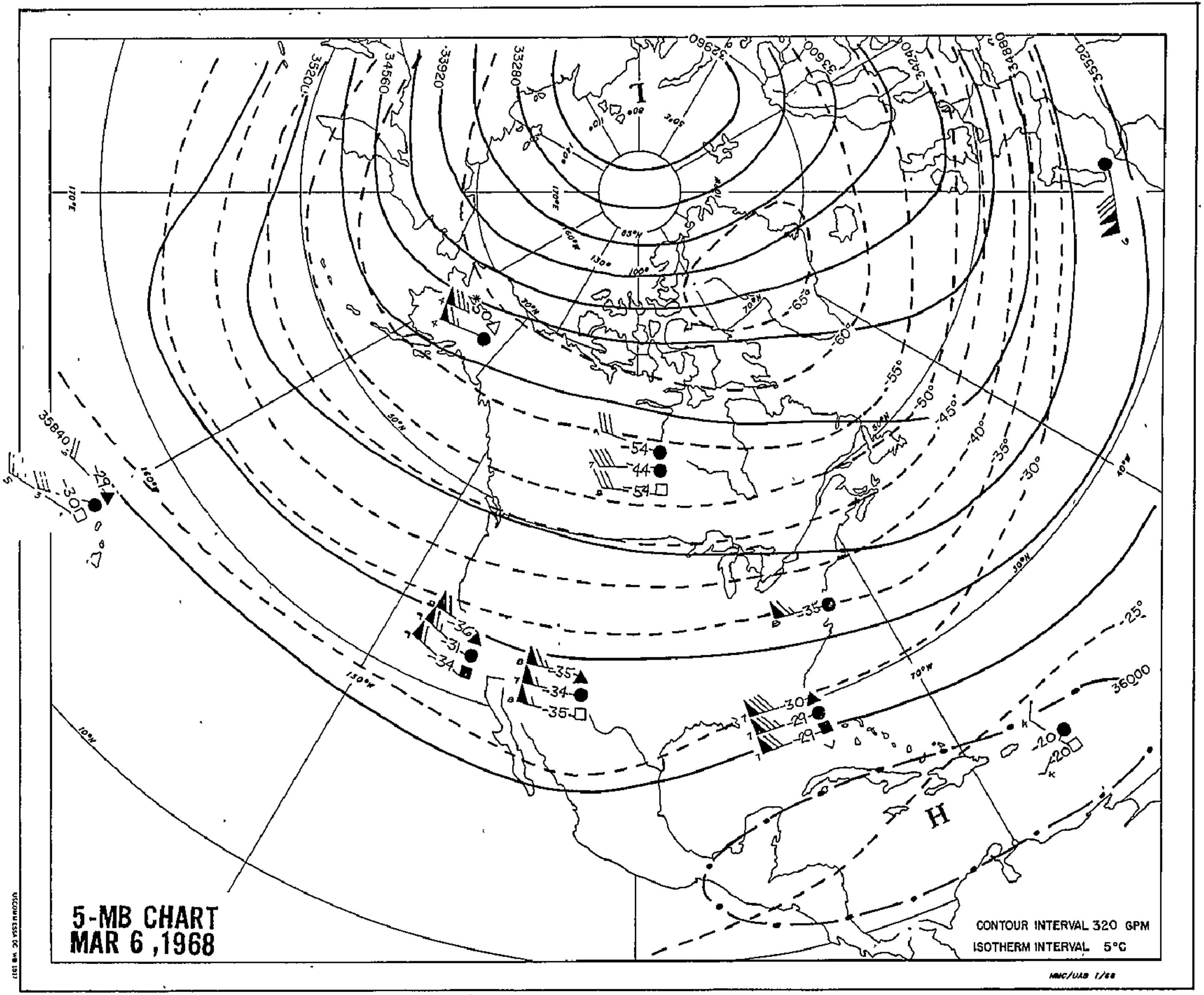

0.4-MB CHART
FEB 21,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
50240
50560
50880
51200
51520
51840
52160
52480
52800
53120
53440
53760
54080
54400
54720
55040
55360


5-MB CHART
FEB 28, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
35840
35200
34560
33920
32960
33600
34240
34880
35520
36000
L
H
-65°
-60°
-55°
-50°
-45°
-40°
-35°
-30°
-25°
130°W
70°W
MIC/UAB 1/68

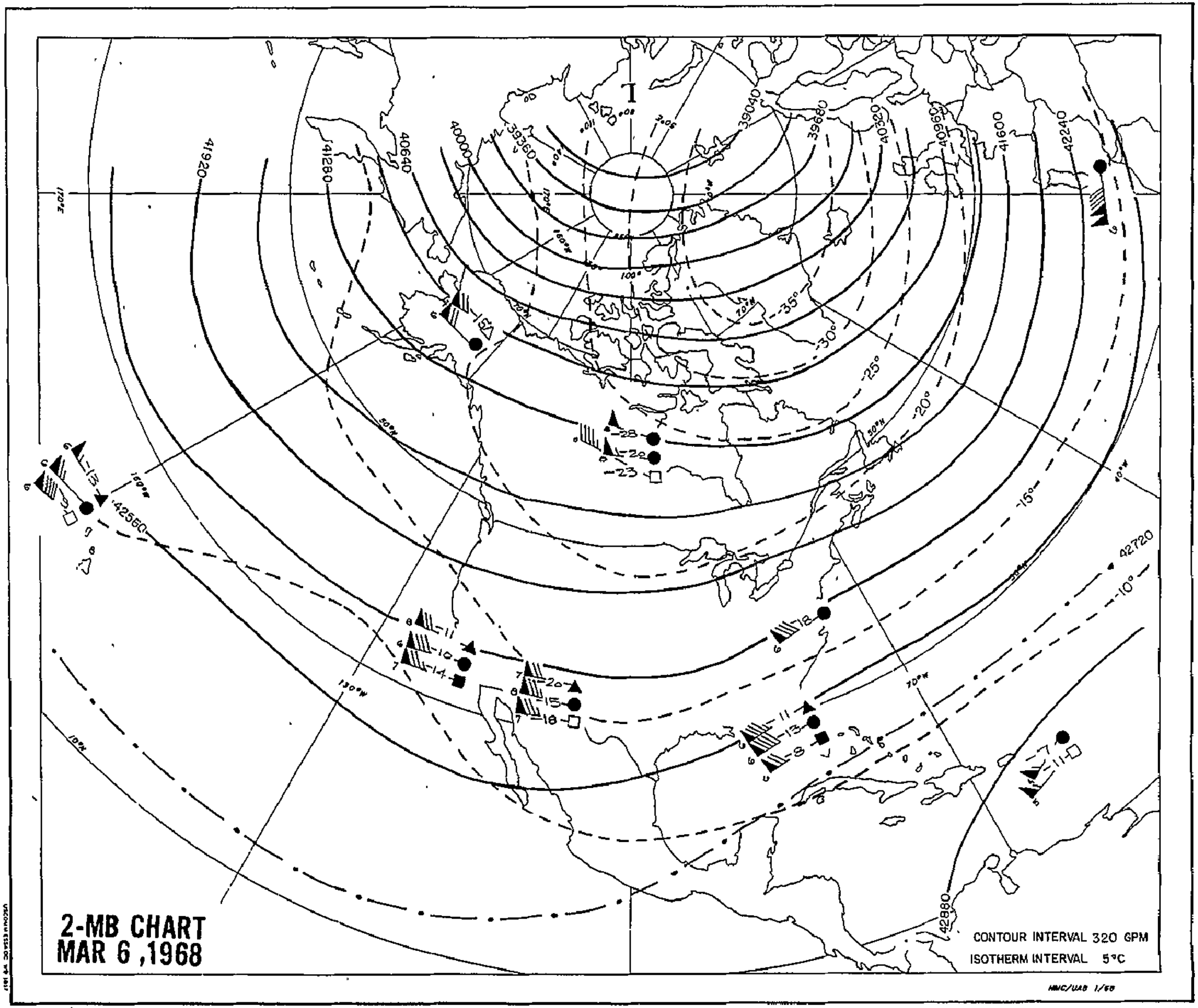


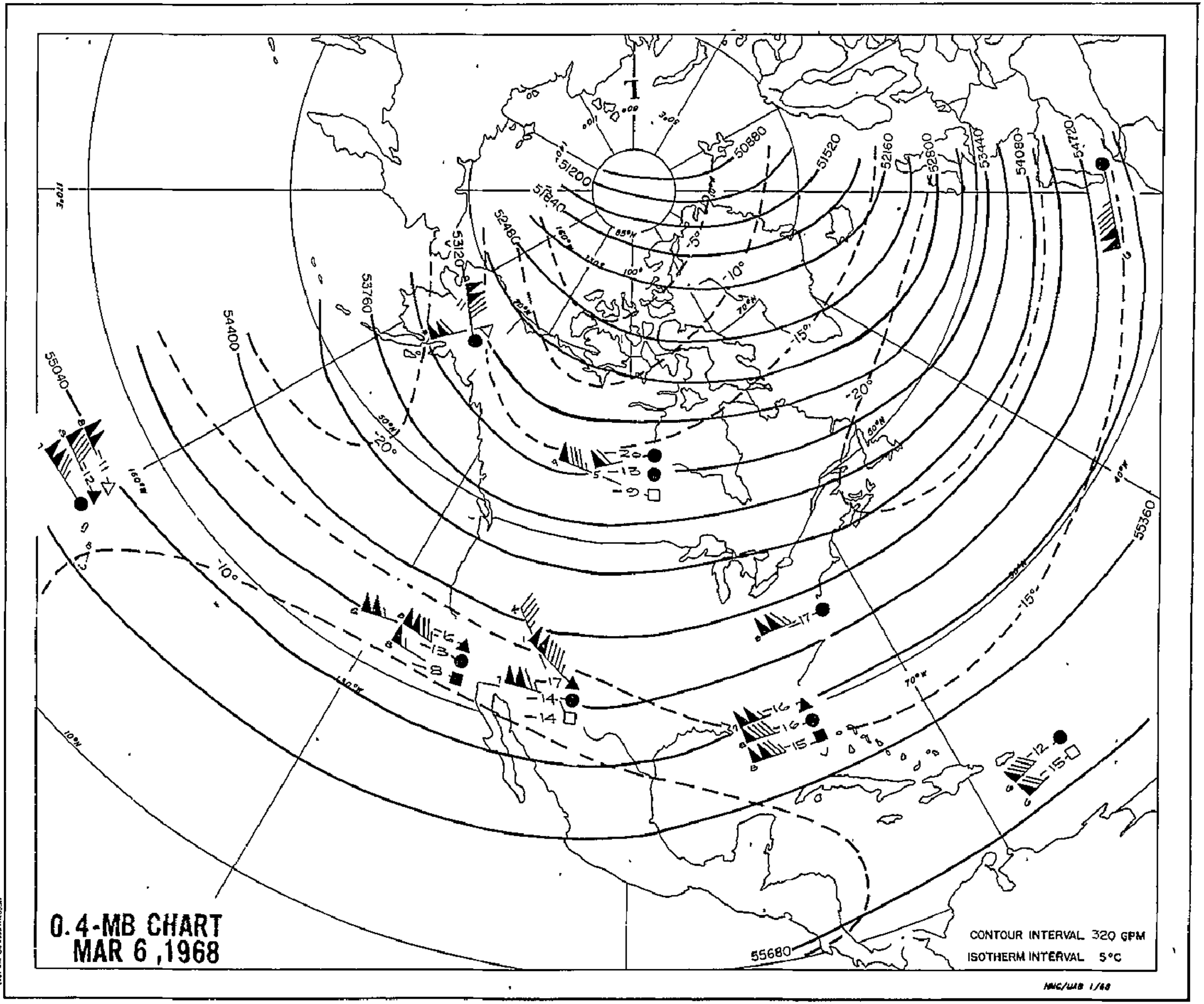
2-MB CHART
FEB 28, 1968

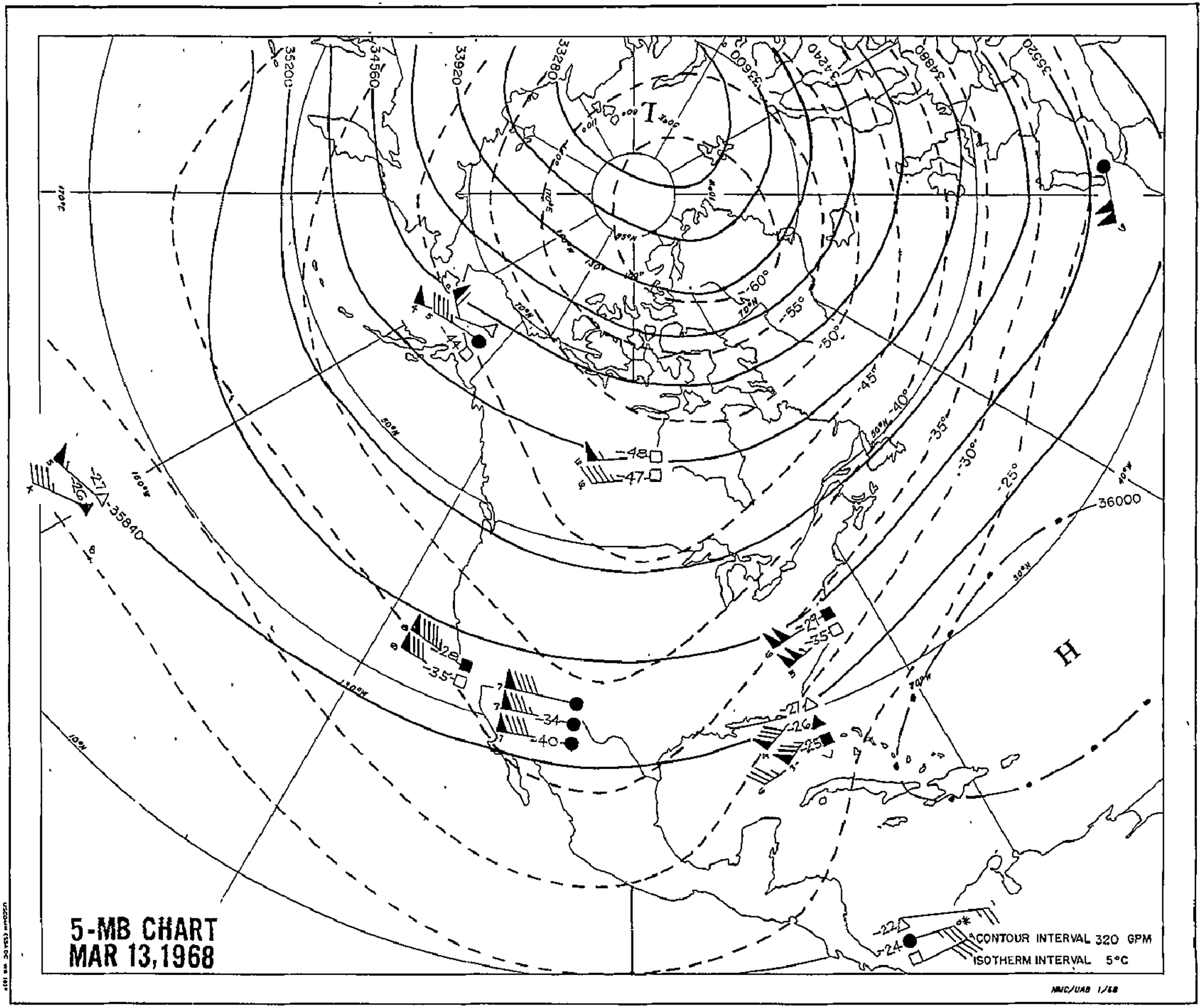

0.4-MB CHART
FEB28,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
NMC/UAB 1/68
50560
51200
51840
52480
53120
53760
54400
50880
51520
52160
52800
53440
54080
54720
55360
55040
55680
0°
-5°
-10°
-15°
-20°
-10°

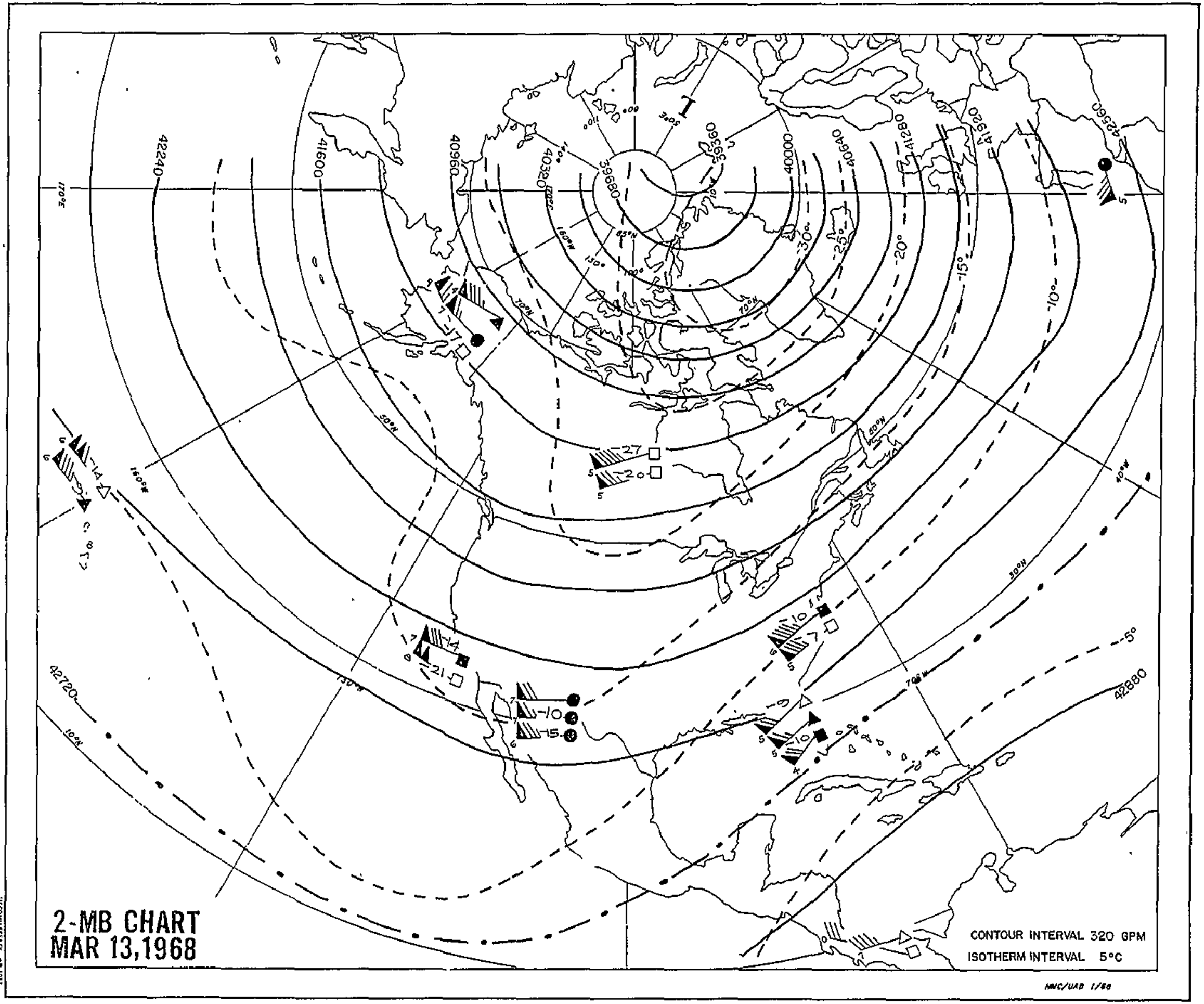


5-MB CHART
MAR 6 ,1968

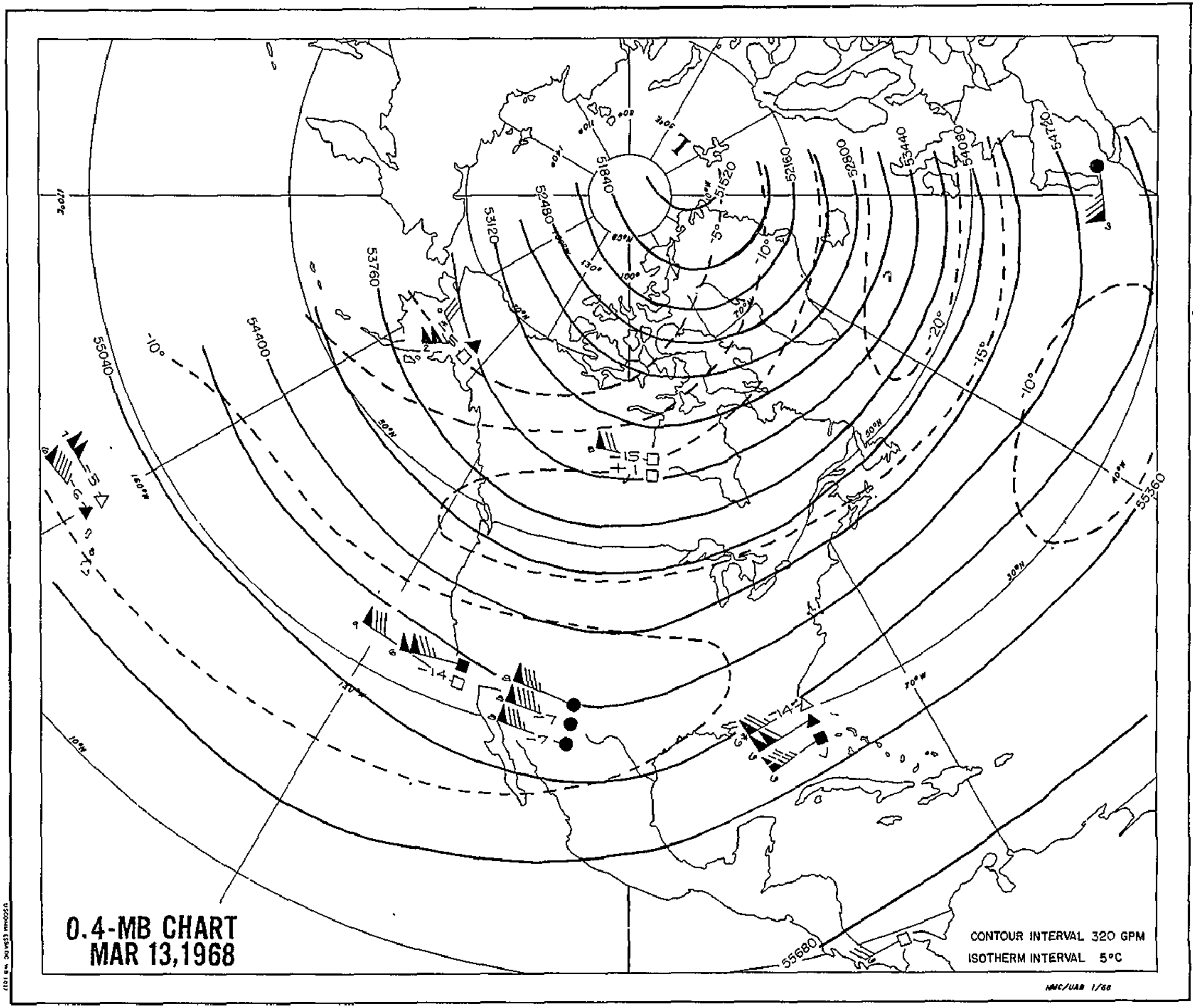

2-MB CHART
MAR 6 ,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
41920
41280
40640
40000
39360
39040
39680
40320
40960
41600
42240
42560
42720
42880
-35°
-30°
-25°
-20°
-15°
-10°
NMC/UAB 1/68

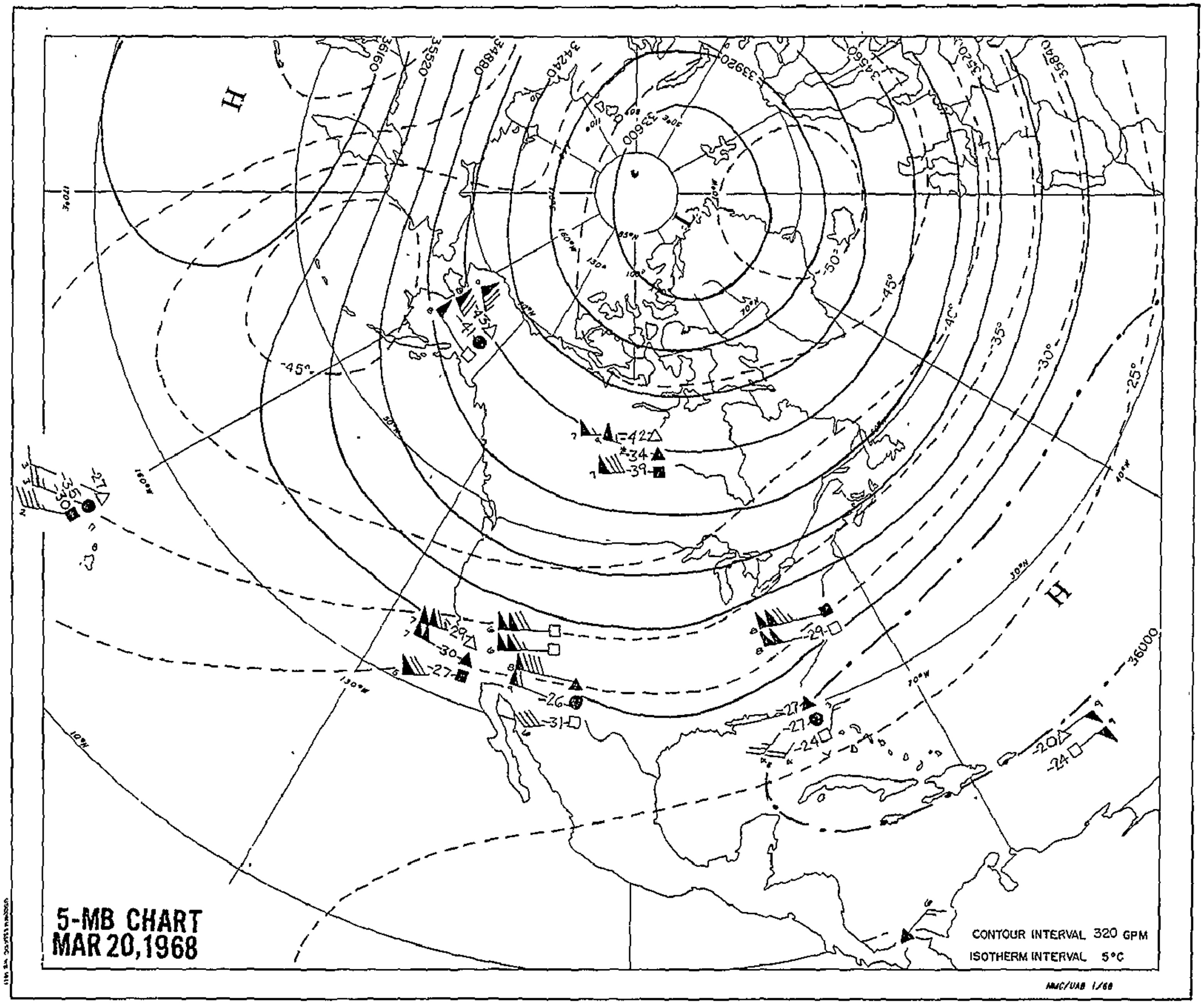

0.4-MB CHART
MAR 6 ,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
50880
51200
51520
51840
52160
52480
52800
53120
53440
53760
54080
54400
54720
55040
55360
55680
-5°
-10°
-15°
-20°

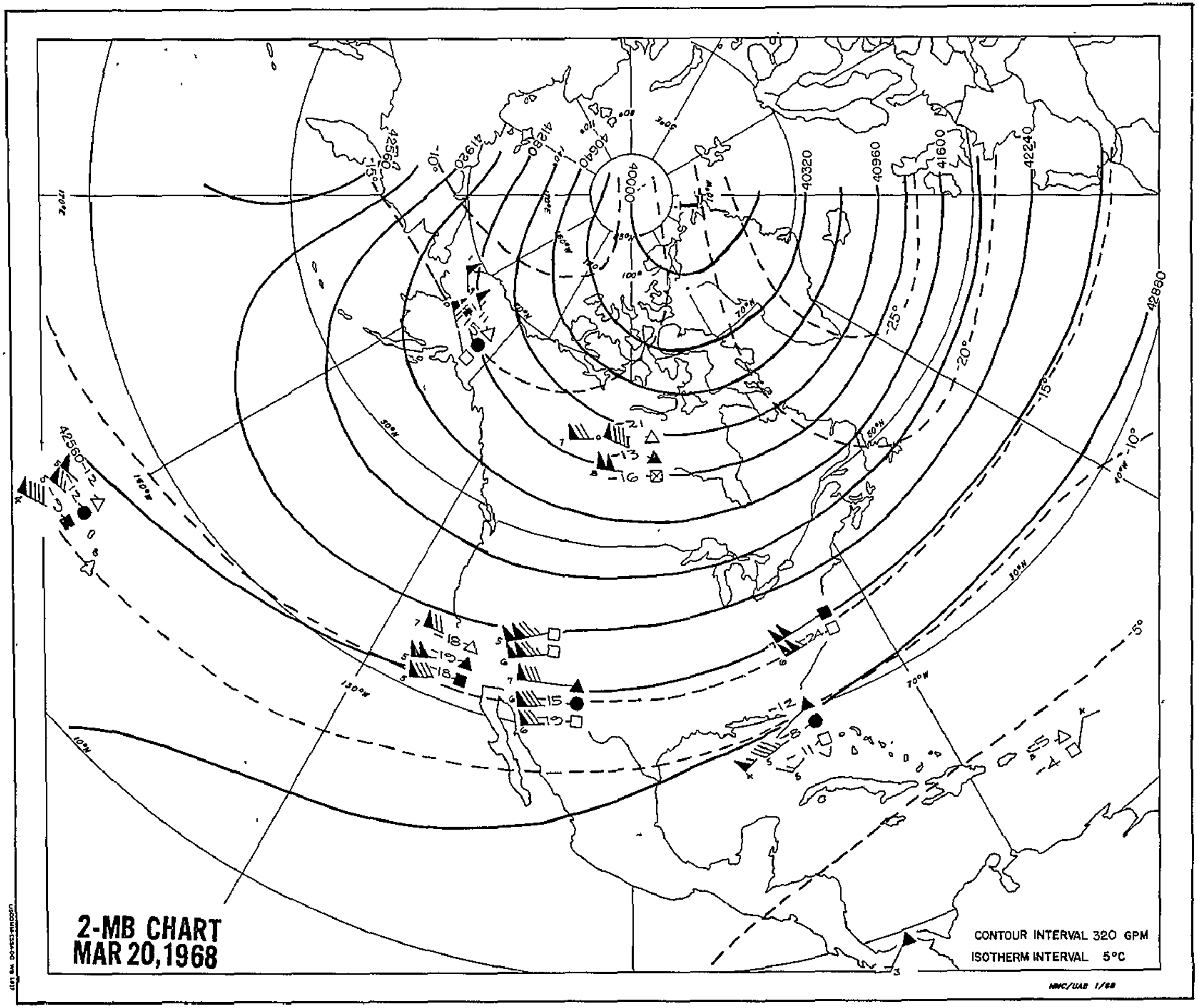

5-MB CHART
MAR 13,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
NMC/UAB 1/68
35200
34560
33920
33280
33600
34240
34880
35520
35840
36000
L
H
-60°
-55°
-50°
-45°
-40°
-35°
-30°
-25°

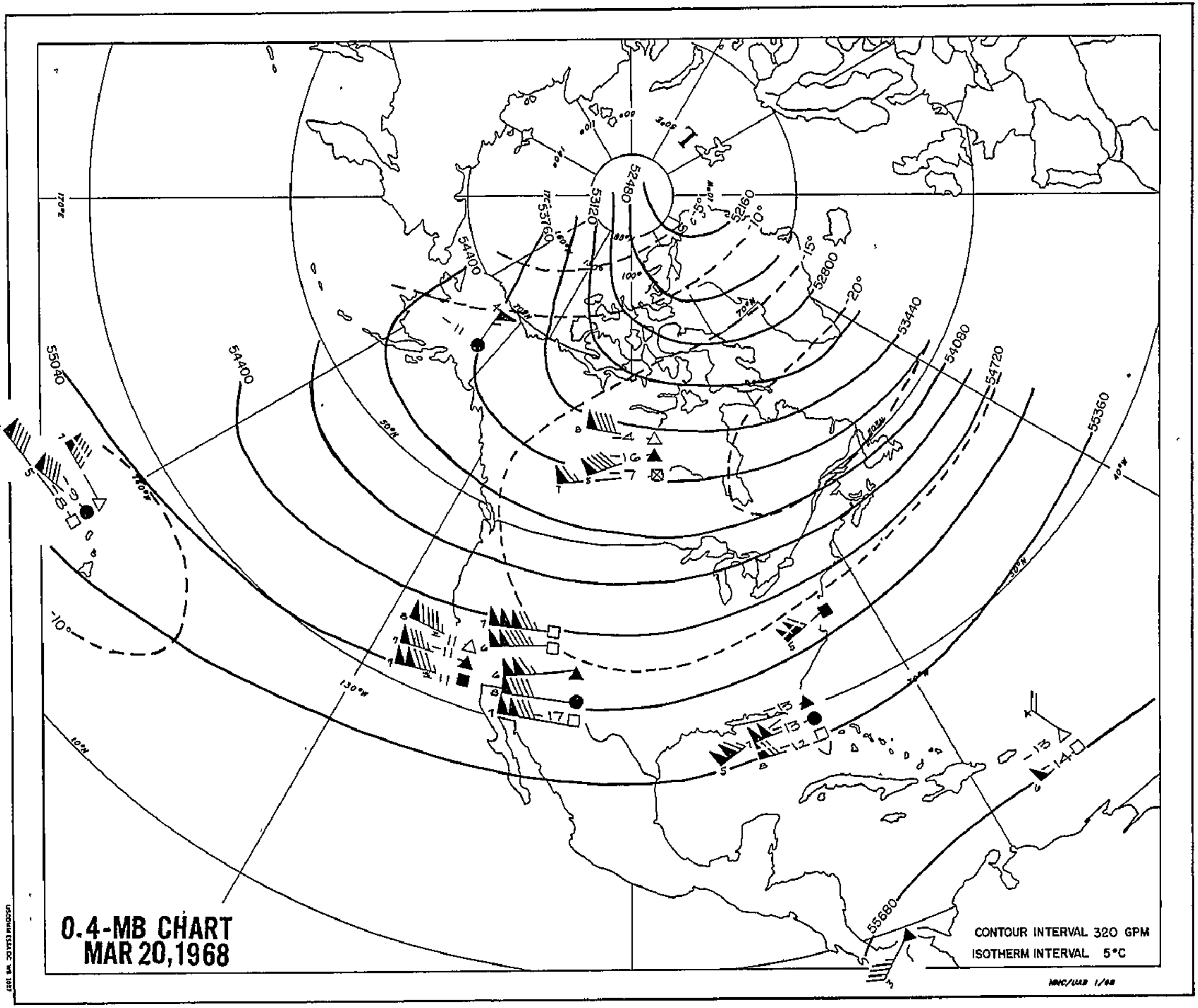


2-MB CHART
MAR 13,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
42240
41600
40960
40320
39680
39360
40000
40640
41280
41920
42560
42720
42880
-30°
-25°
-20°
-15°
-10°
-5°

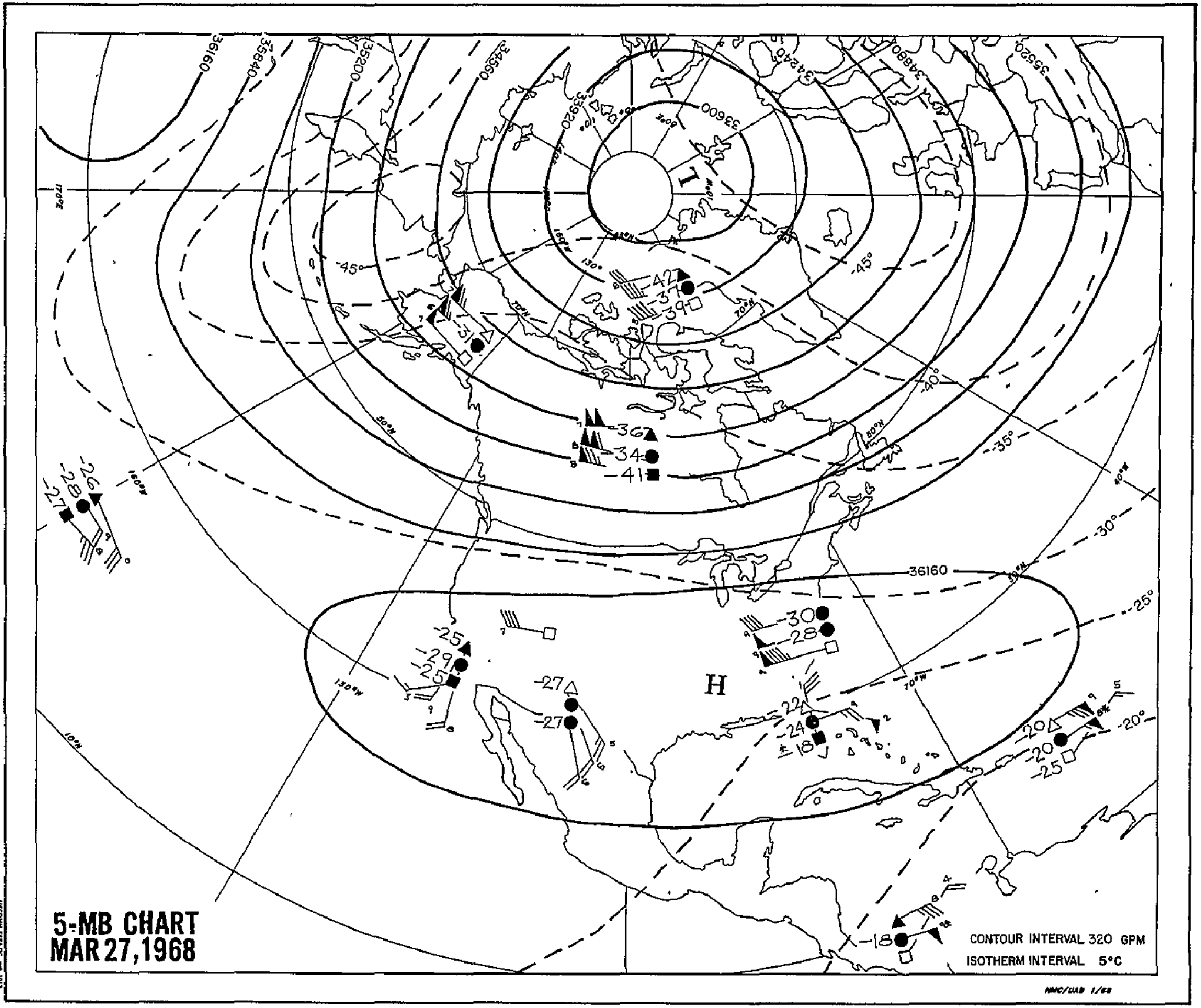

0.4-MB CHART
MAR 13,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
51520
51840
52160
52480
52800
53120
53440
53760
54080
54400
54720
55040
55360
55680
-5°
-10°
-15°
-20°
NMC/UAB 1/68

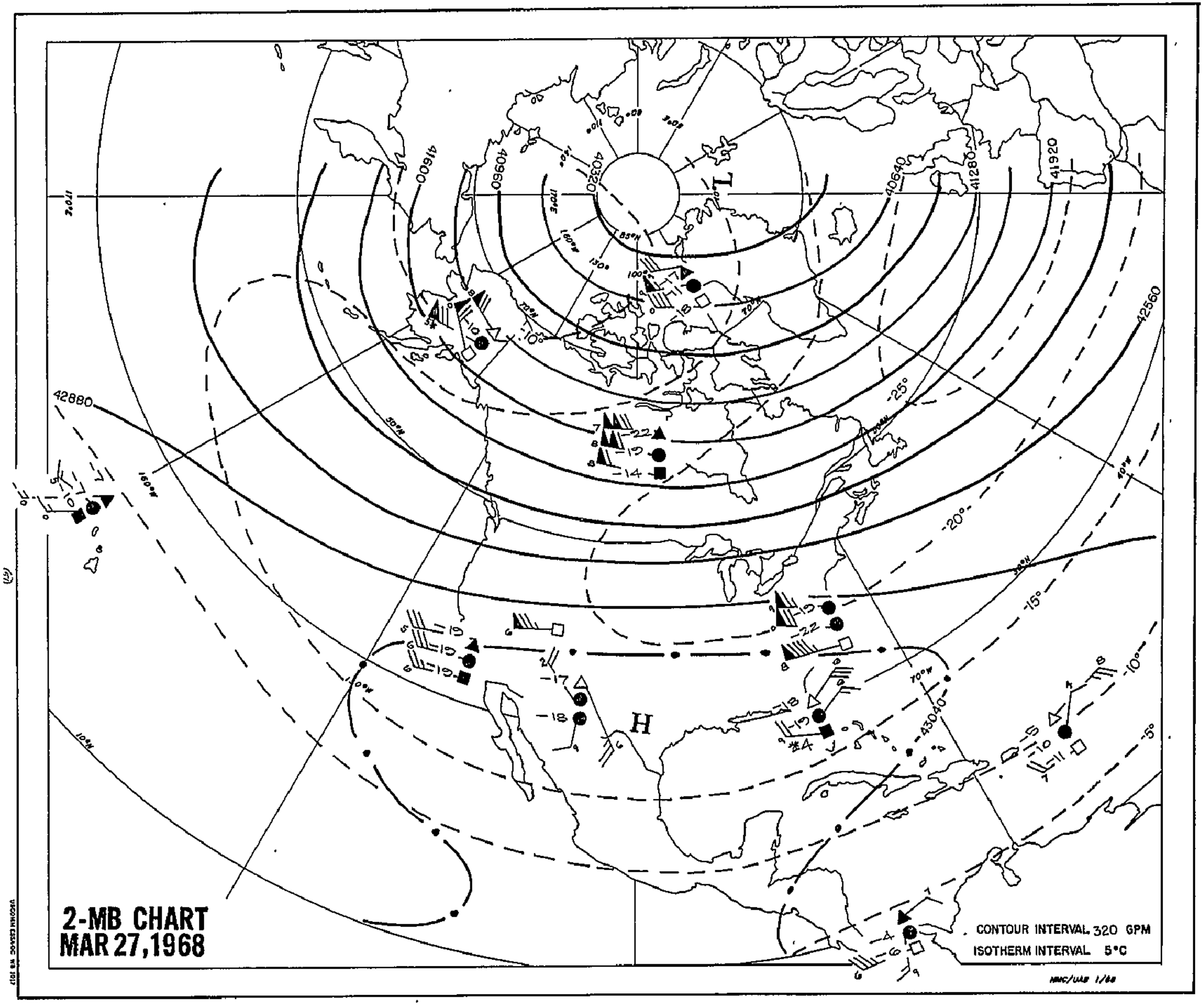

5-MB CHART
MAR 20,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
36000
33920
33600
34240
34880
35520
36160
-45°
-50°
-40°
-35°
-30°
-25°
H
L

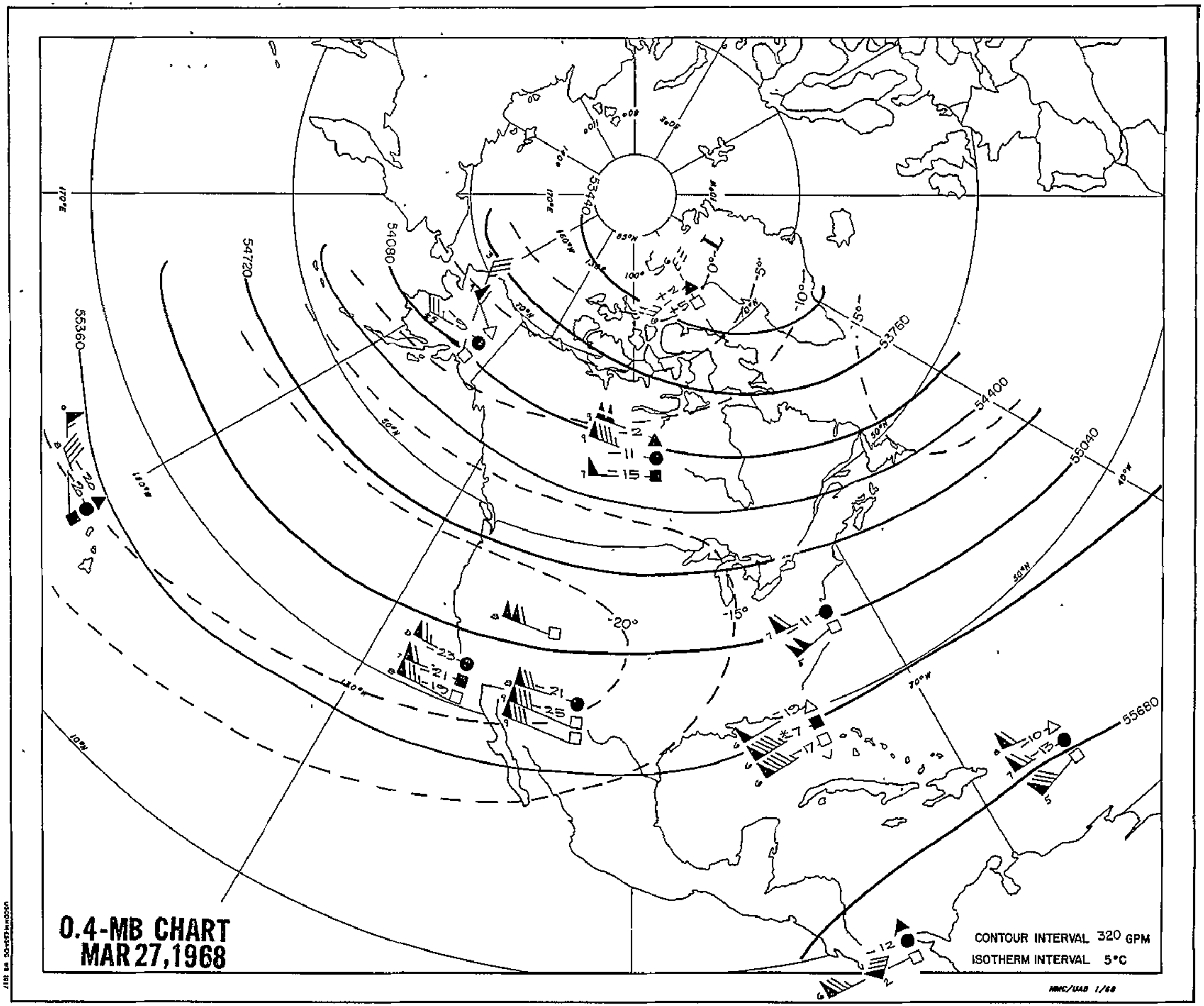

2-MB CHART
MAR 20,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
40000
40320
40640
40960
41280
41600
41920
42240
42560
42880
-10°
-15°
-20°
-25°
-5°
NMC/UAB 1/68

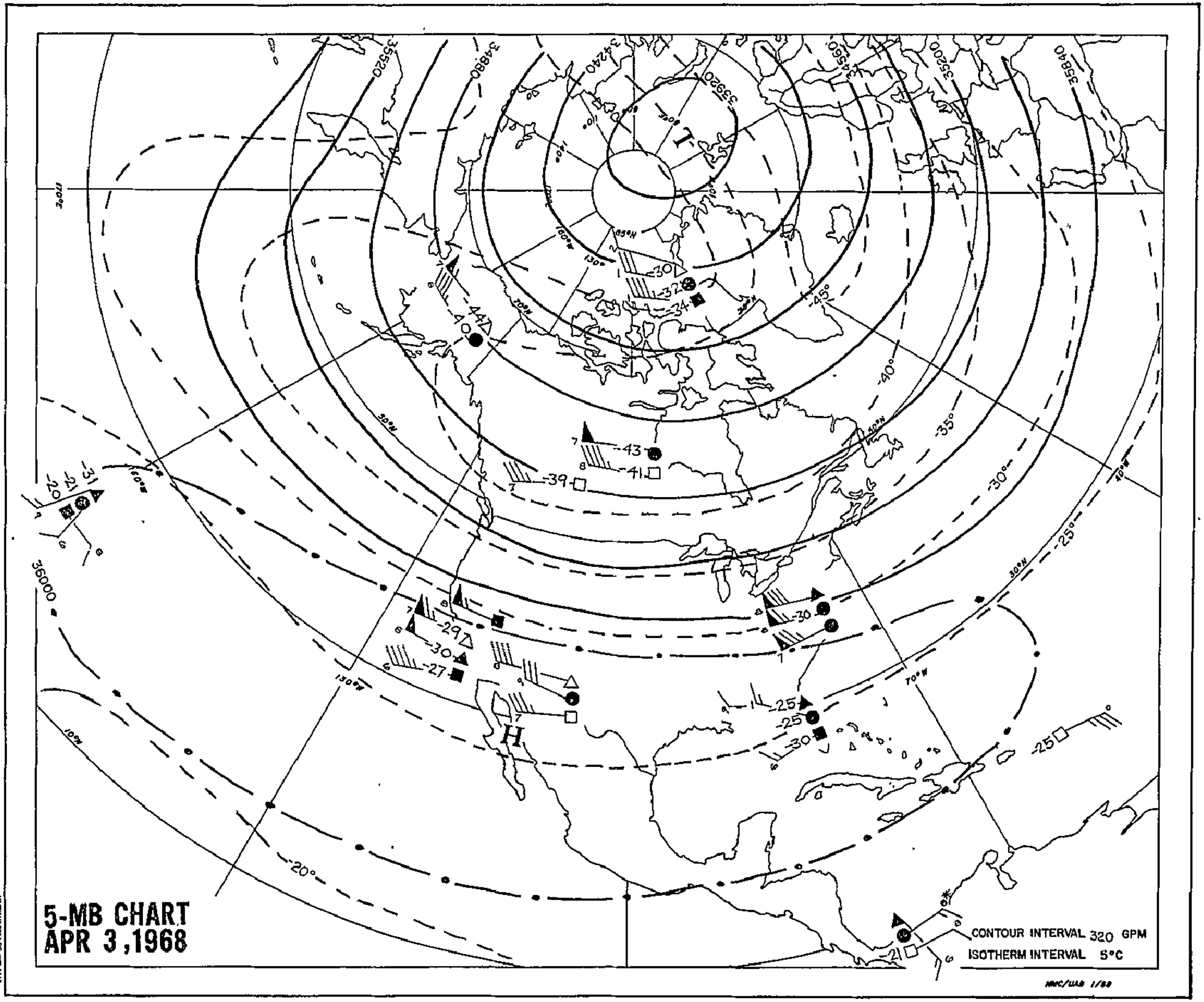


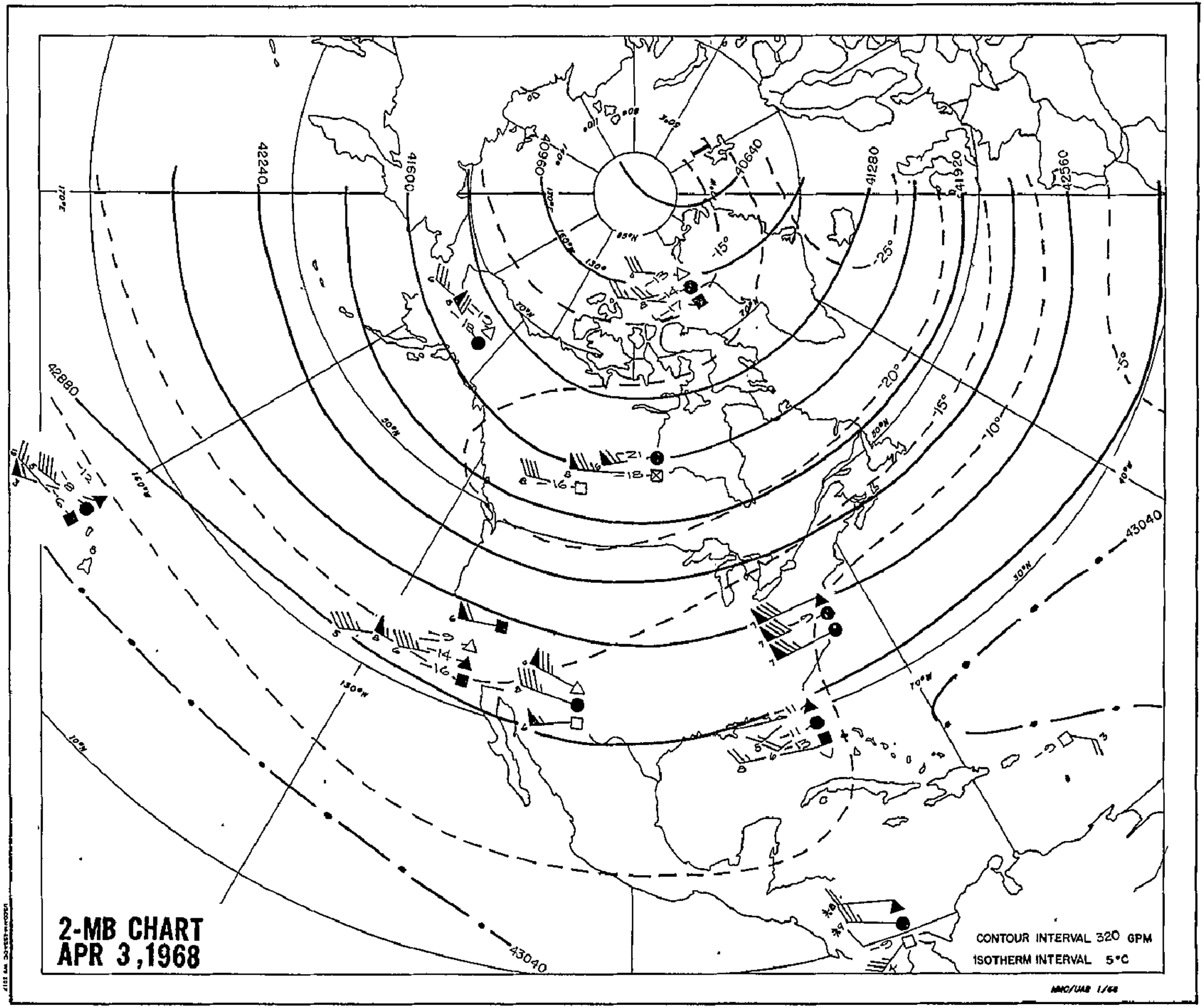
0.4-MB CHART
MAR 20,1968

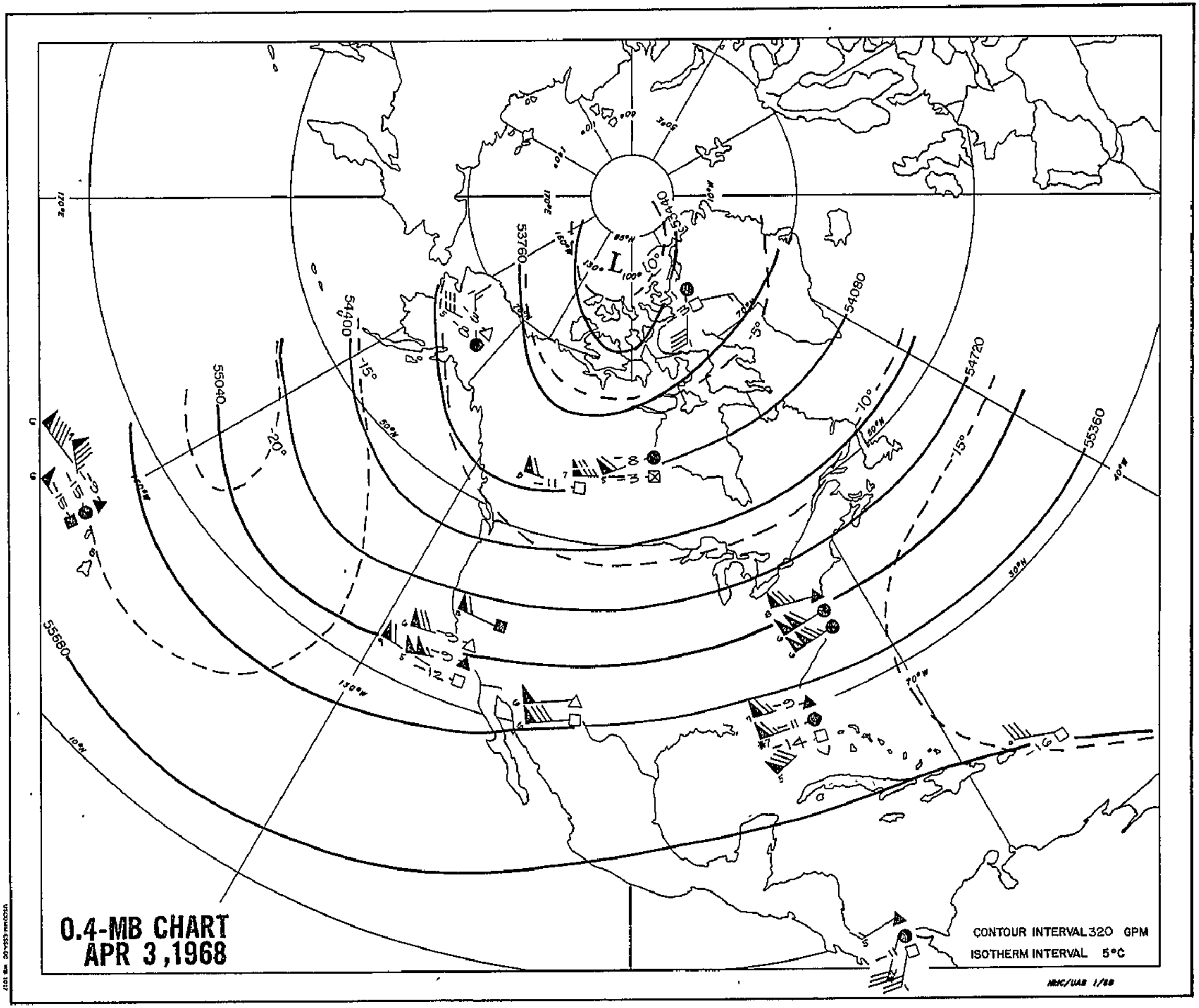

5-MB CHART
MAR 27,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
36160
35840
35520
35200
34880
34560
34240
33920
33600
36160
L
H
-45°
-45°
-40°
-35°
-30°
-25°
-20°

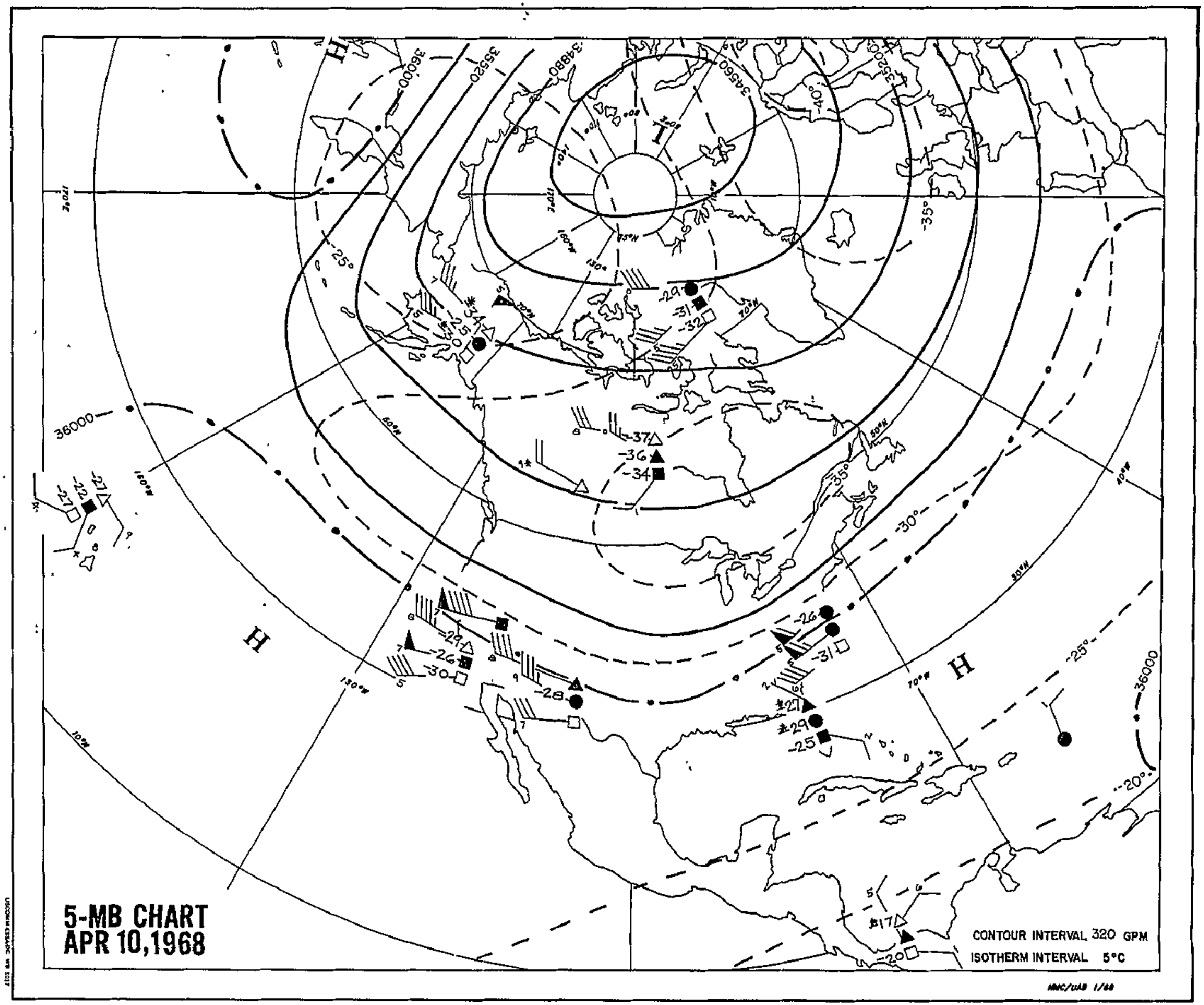

2-MB CHART
MAR 27,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
42880
42560
41920
41600
41280
40960
40640
40320
43040
L
H
-25°
-20°
-15°
-10°
-5°

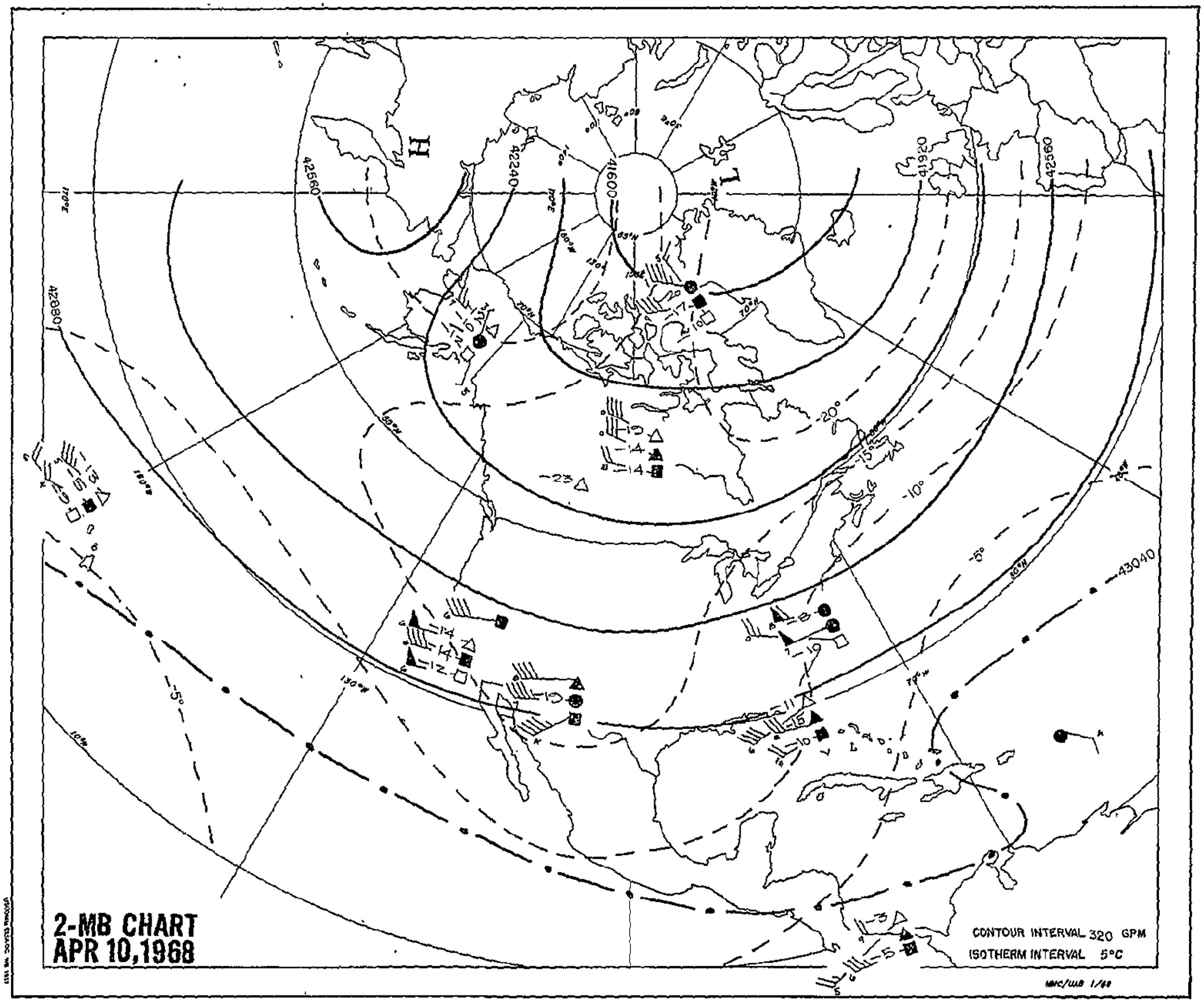

0.4-MB CHART
MAR 27,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
53440
53760
54080
54400
54720
55040
55360
55680
-10°
-15°
-20°
-5°
0°
+5
-2
-11
-15
-23
-21
-19
-25
-17
-13
-12
NMC/UAB 1/68

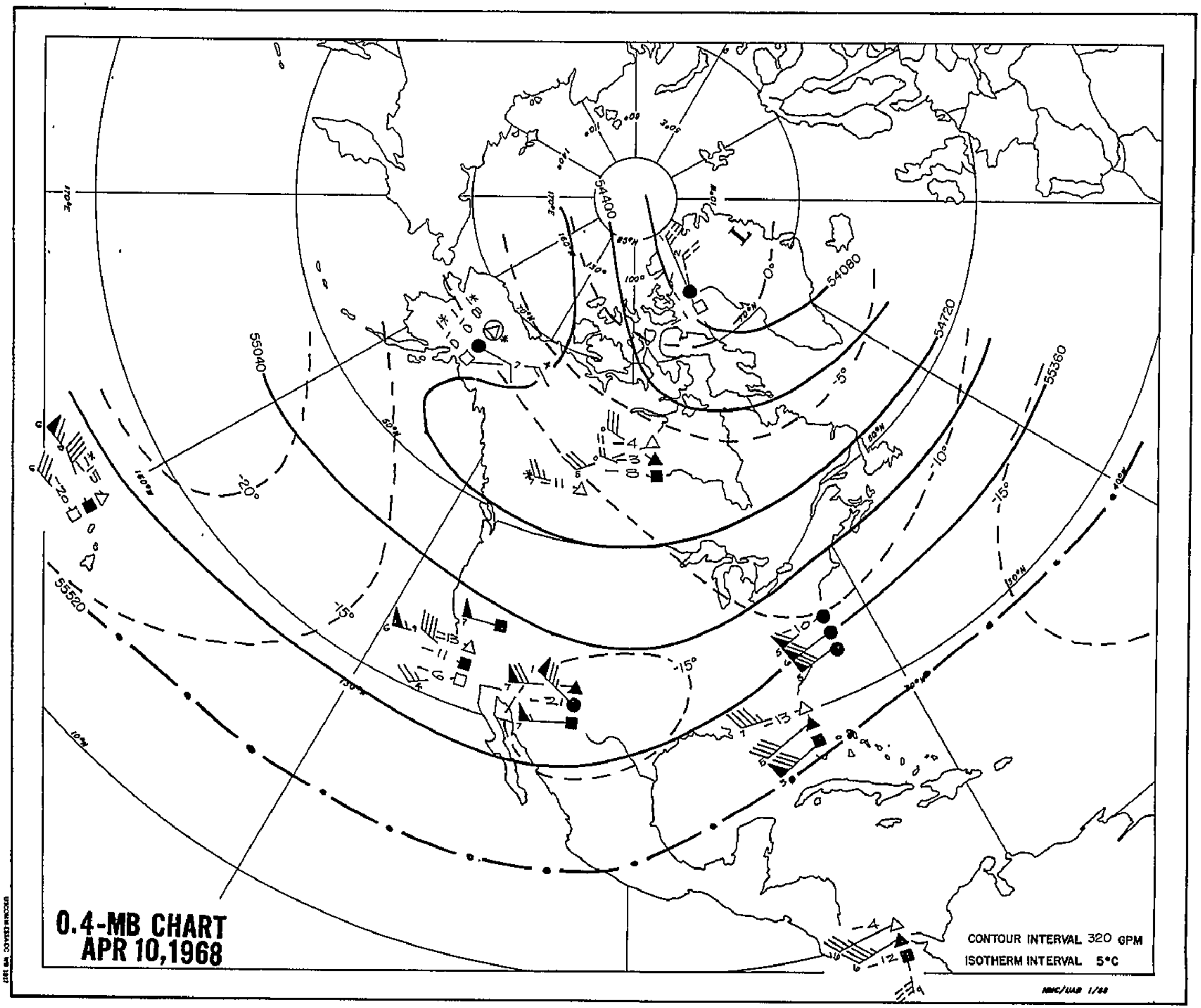

5-MB CHART
APR 3,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
-20°
-25°
-30°
-35°
-40°
-45°
36000
35520
34880
34240
33920
35840
35200

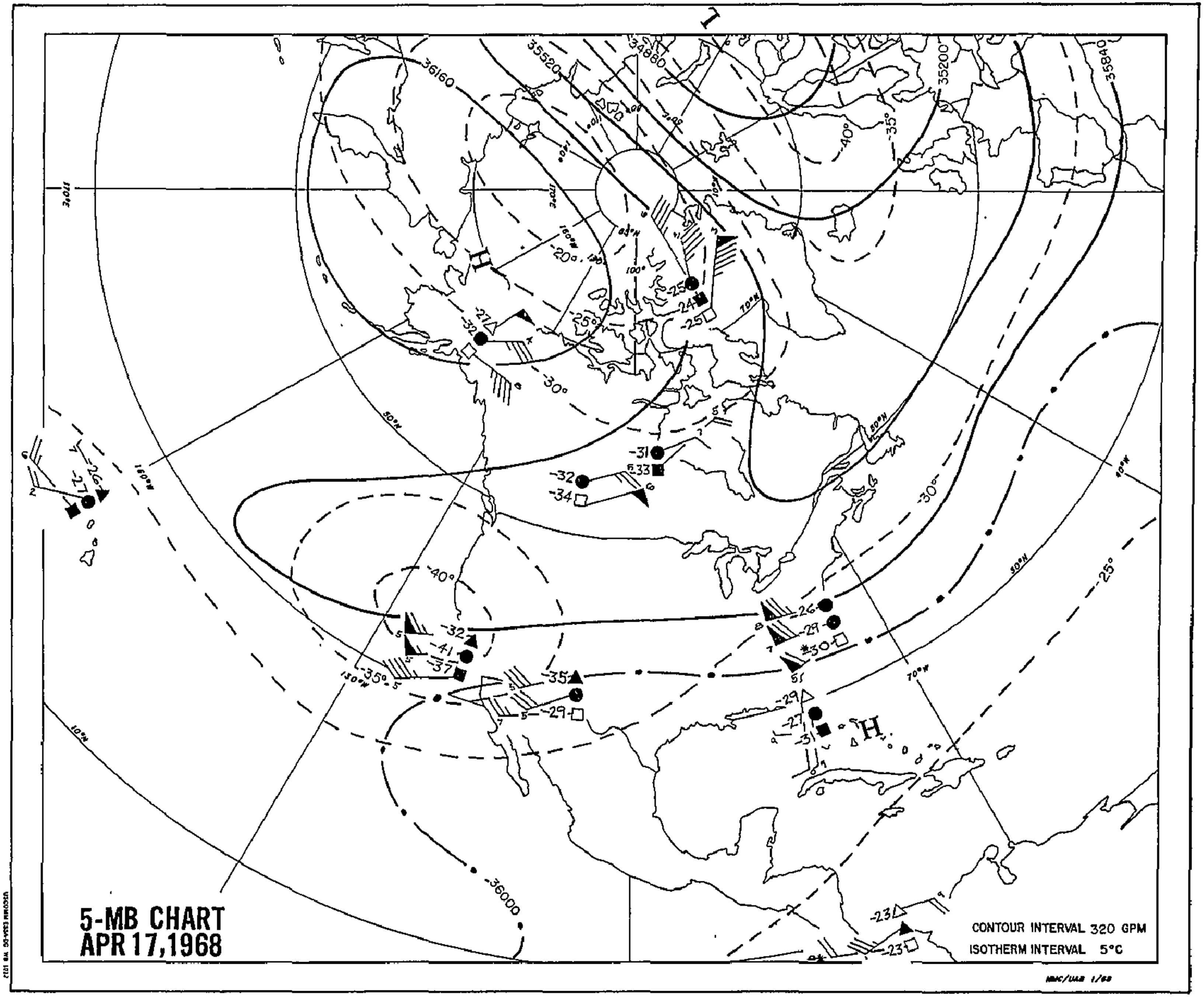

2-MB CHART
APR 3,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
42880
42240
41600
40960
40640
41280
41920
42560
43040
43040
-15°
-25°
-20°
-15°
-10°
-5°

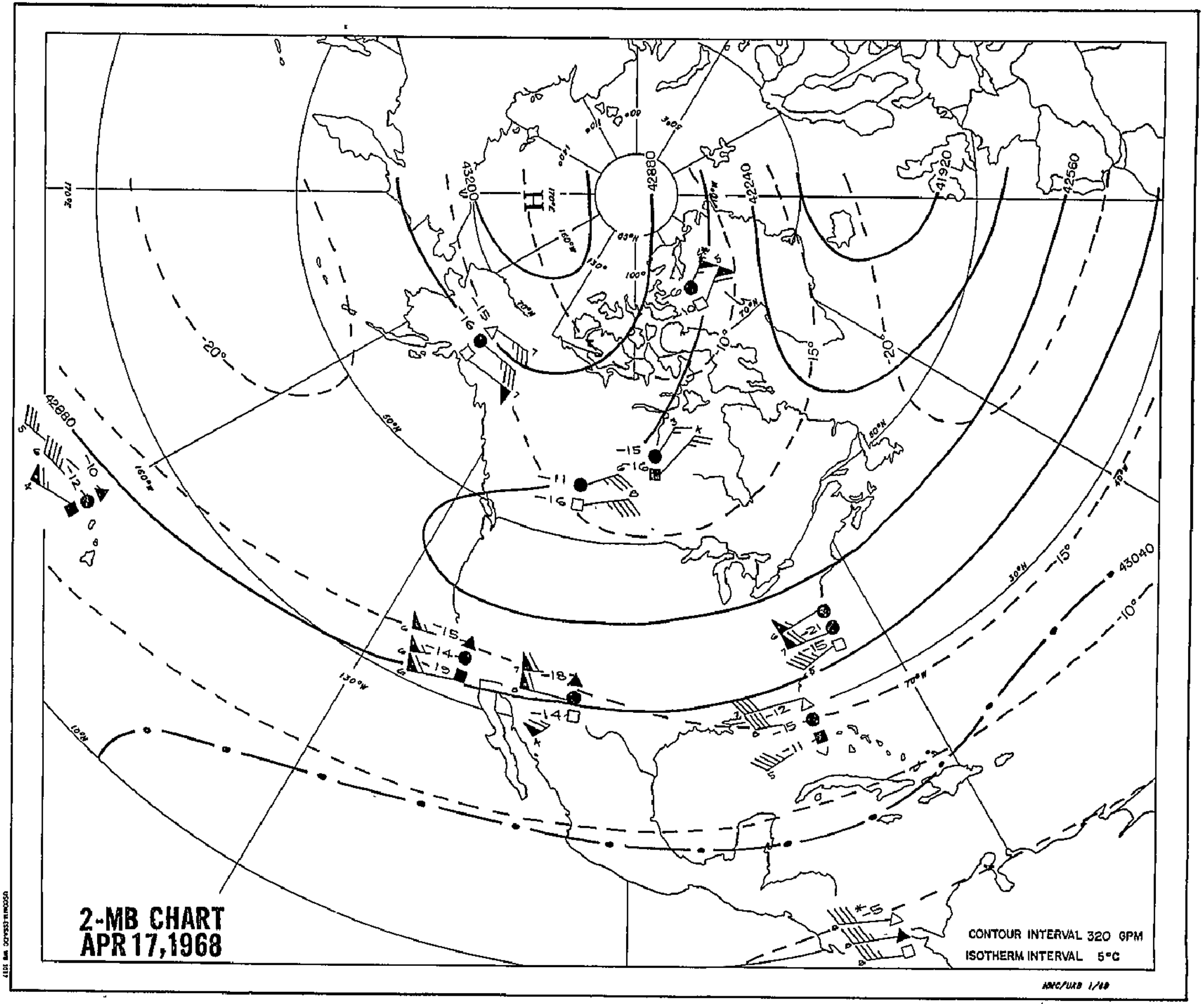

0.4-MB CHART
APR 3,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
53440
53760
54080
54400
54720
55040
55360
55680
L
-10°
-5°
-15°
-20°


5-MB CHART
APR 10,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
36000
35520
34880
34560
35200
-25°
-30°
-35°
-40°
-20°
H
L

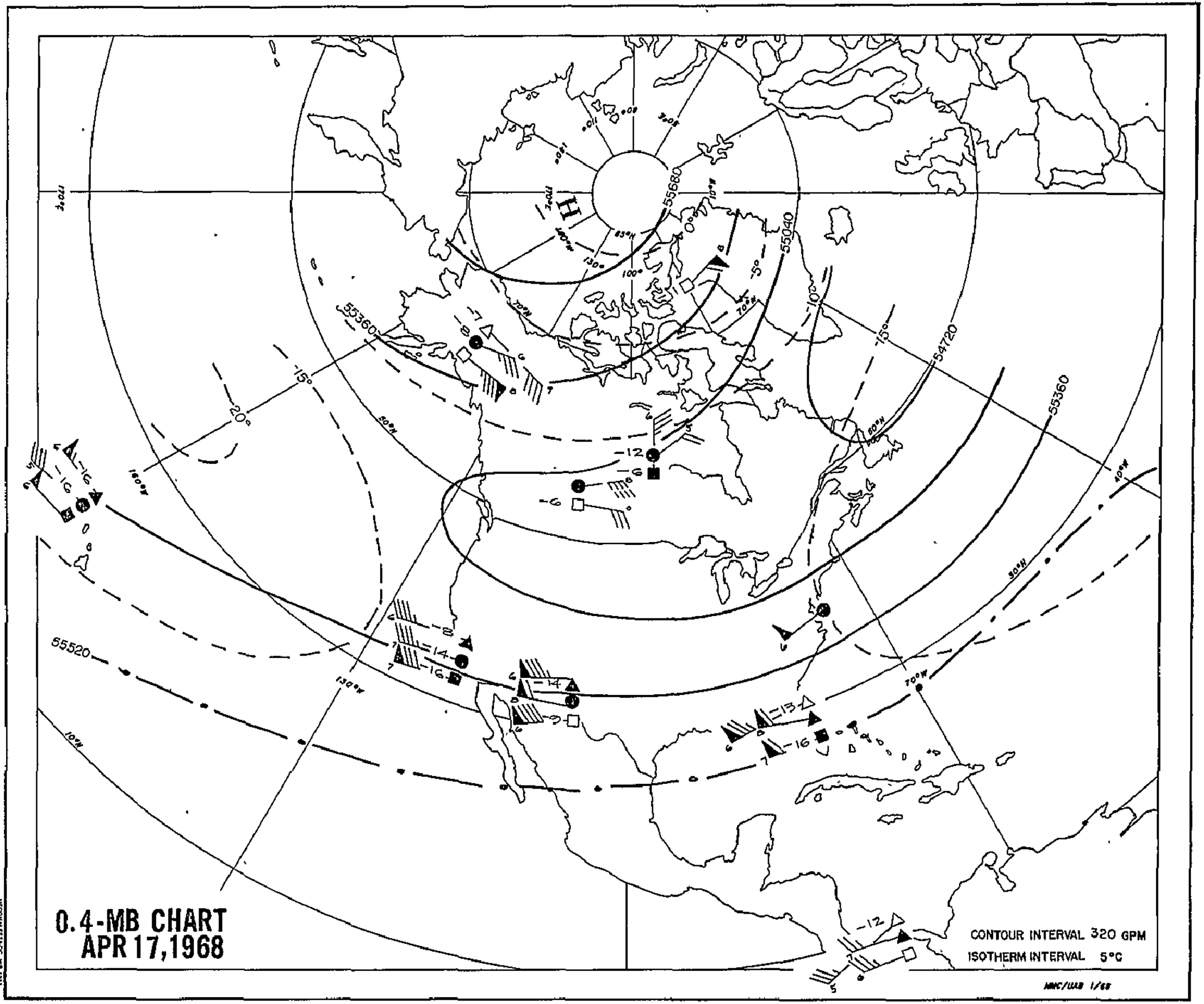

2-MB CHART
APR 10,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
L
42560
42240
41600
41920
42880
43040
-20°
-15°
-10°
-5°

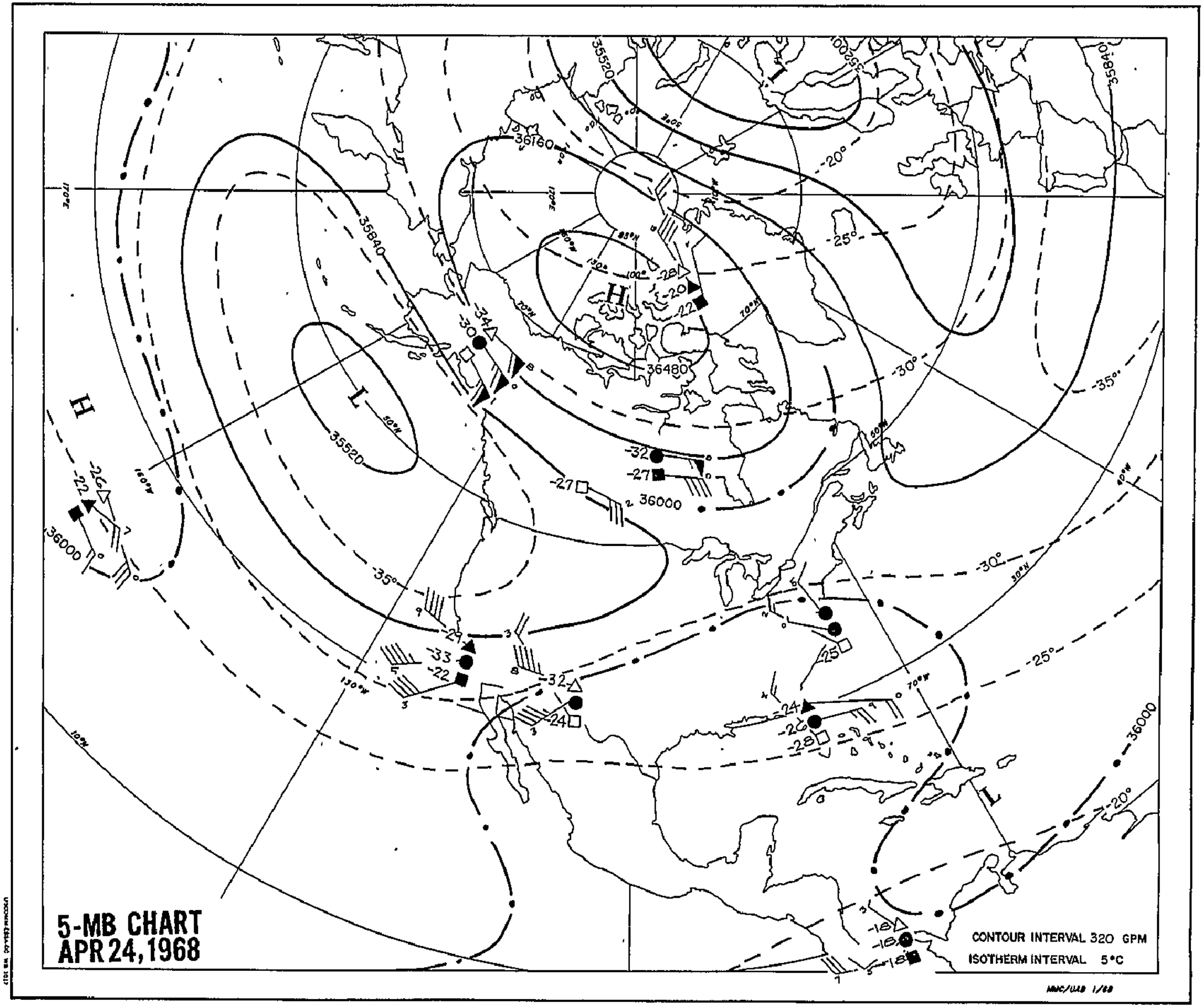

0.4-MB CHART
APR 10,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
54400
54080
54720
55040
55360
55520
0°
-5°
-10°
-15°
-20°

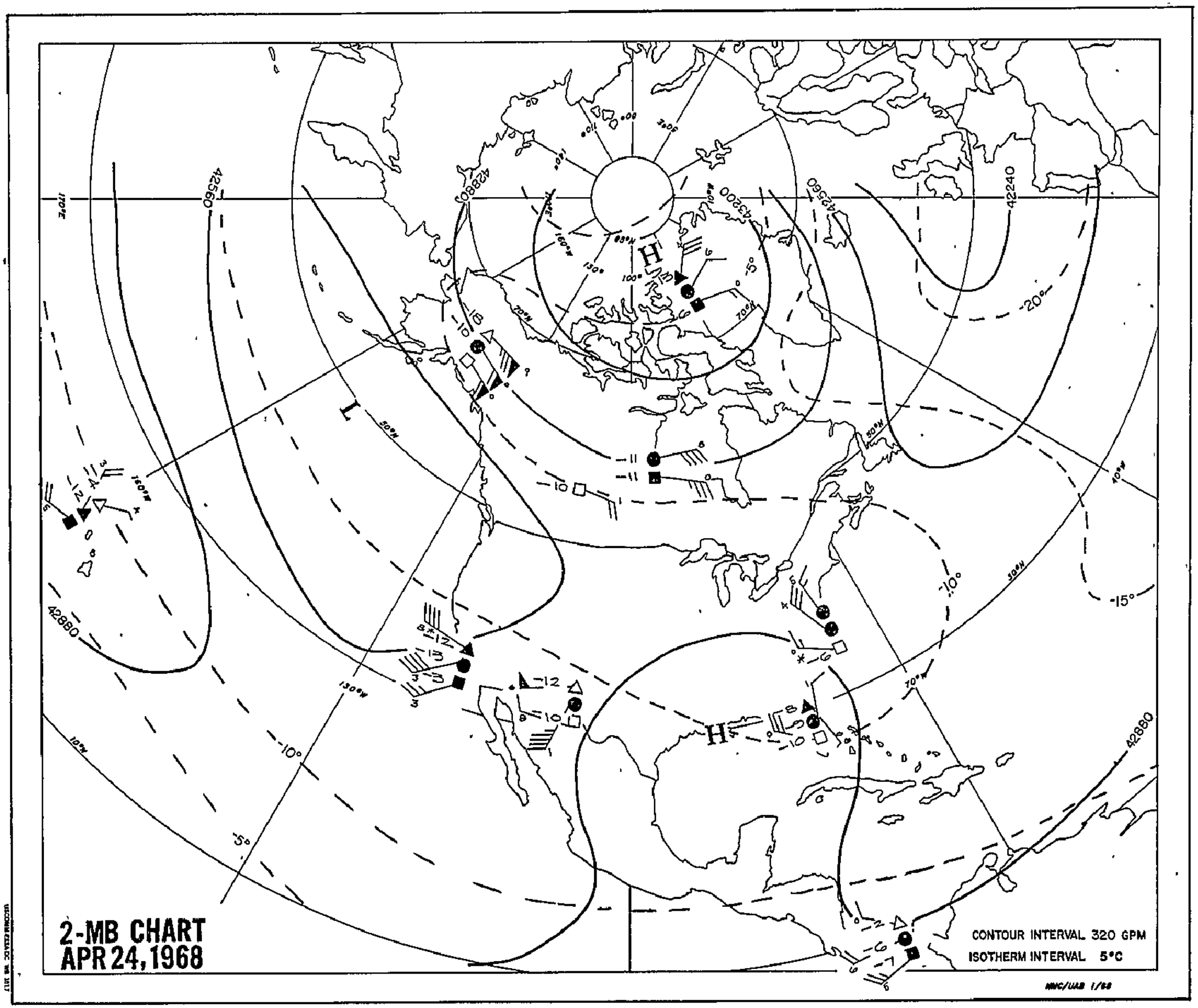

5-MB CHART
APR 17,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
36160
35520
34880
35200
35840
36000
H
L
H
-20°
-25°
-30°
-35°
-40°

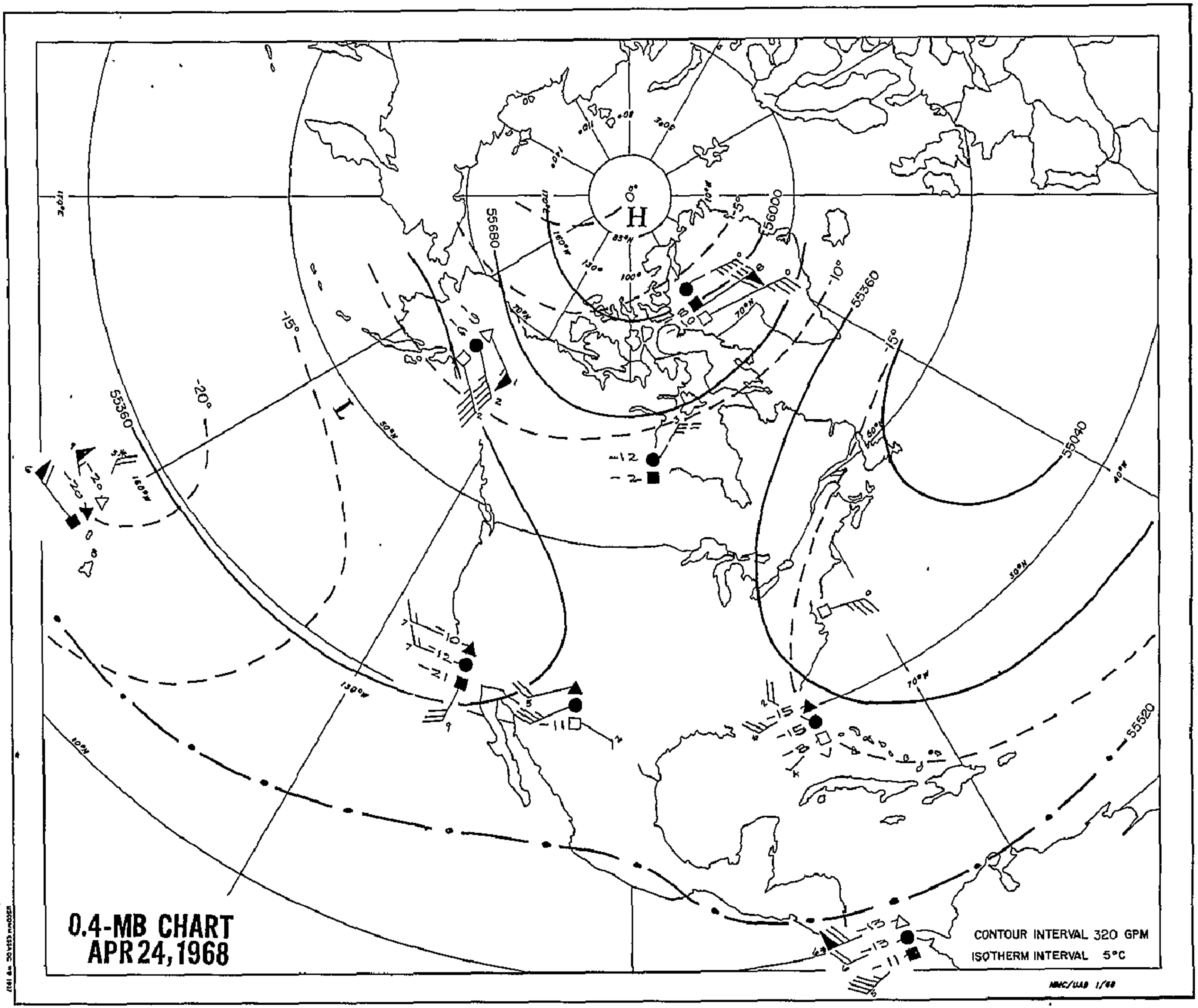


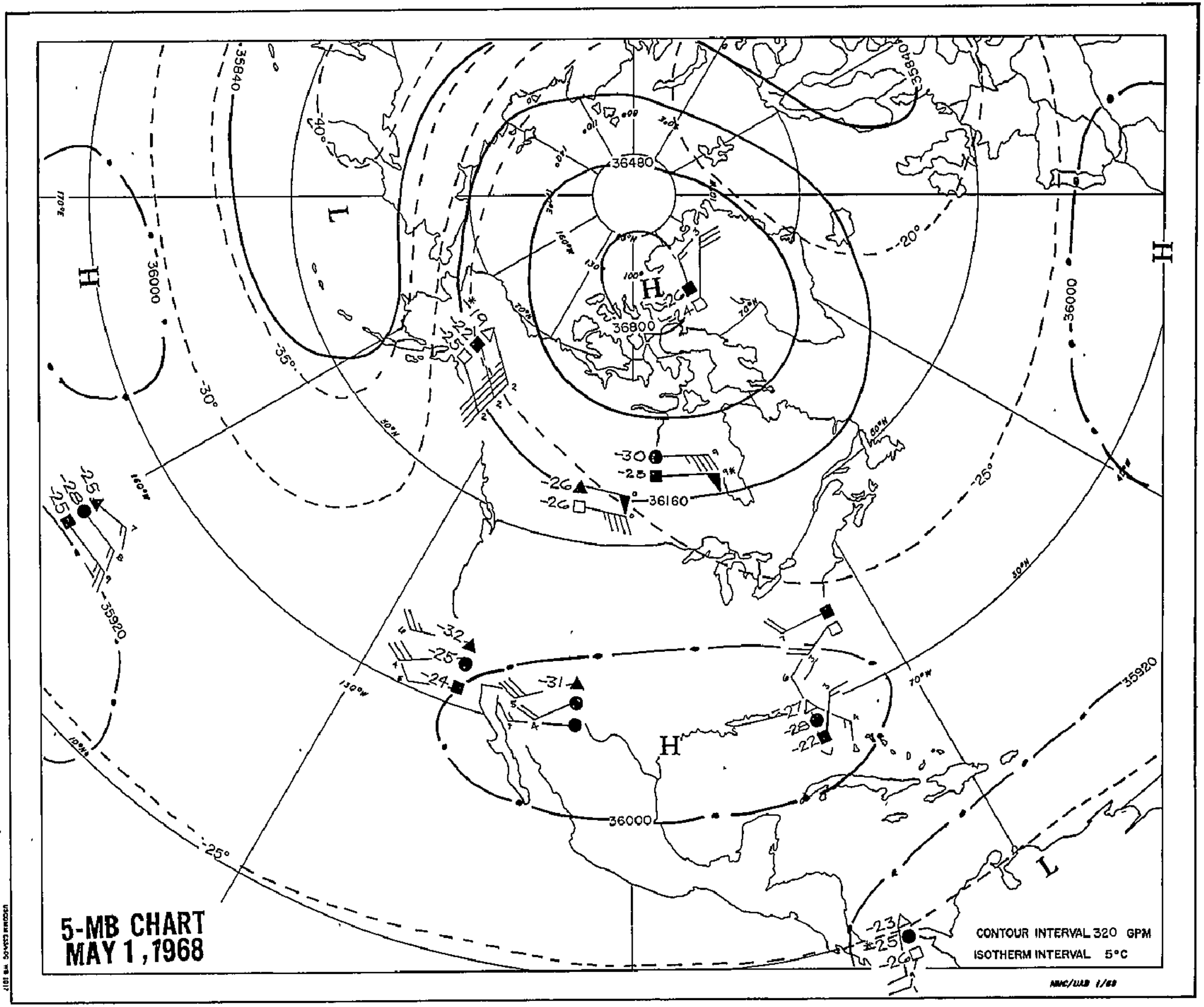
2-MB CHART
APR 17,1968

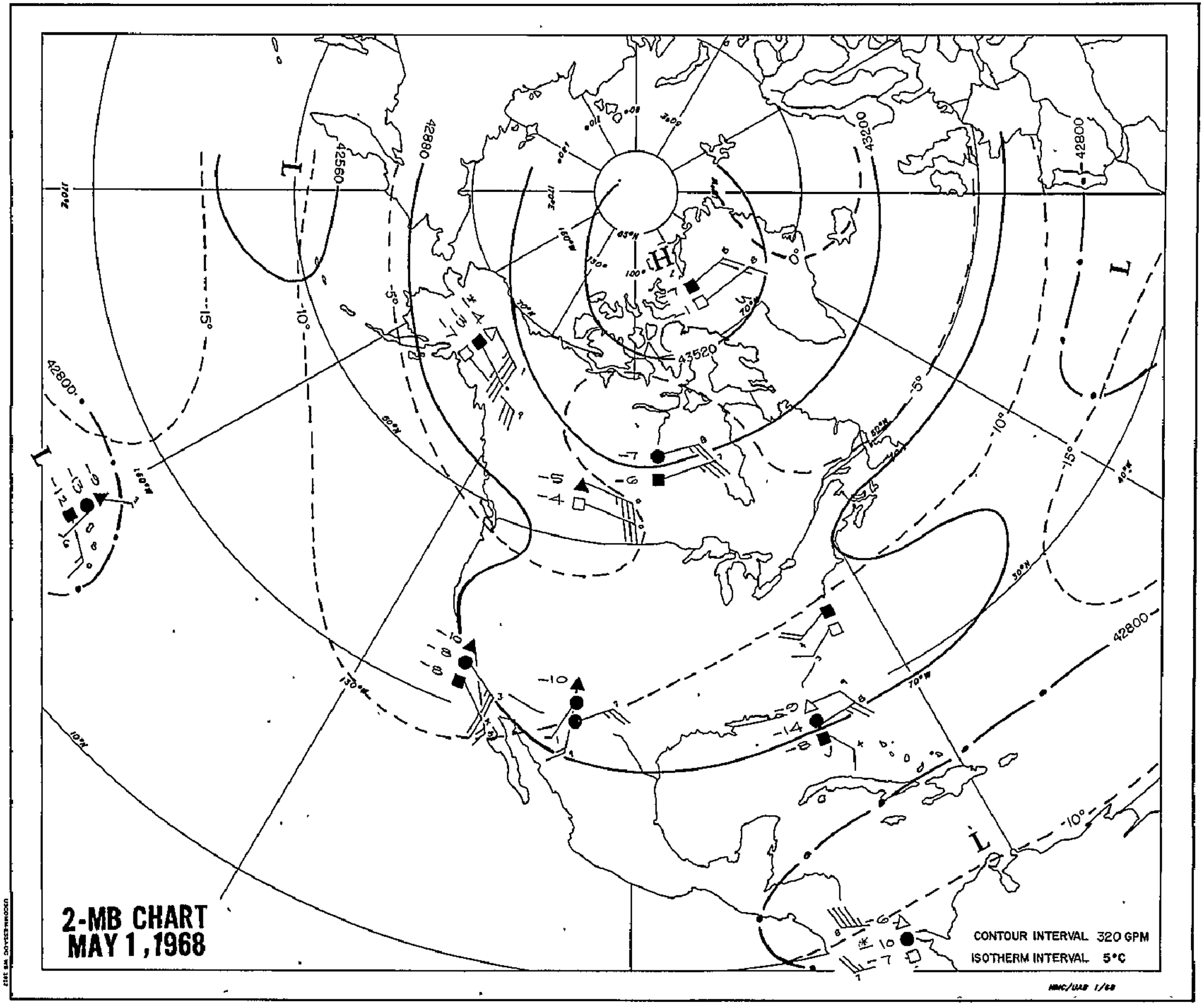

0.4-MB CHART
APR 17,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
55680
55360
55040
54720
55360
55520
-5°
-10°
-15°
-15°
-20°

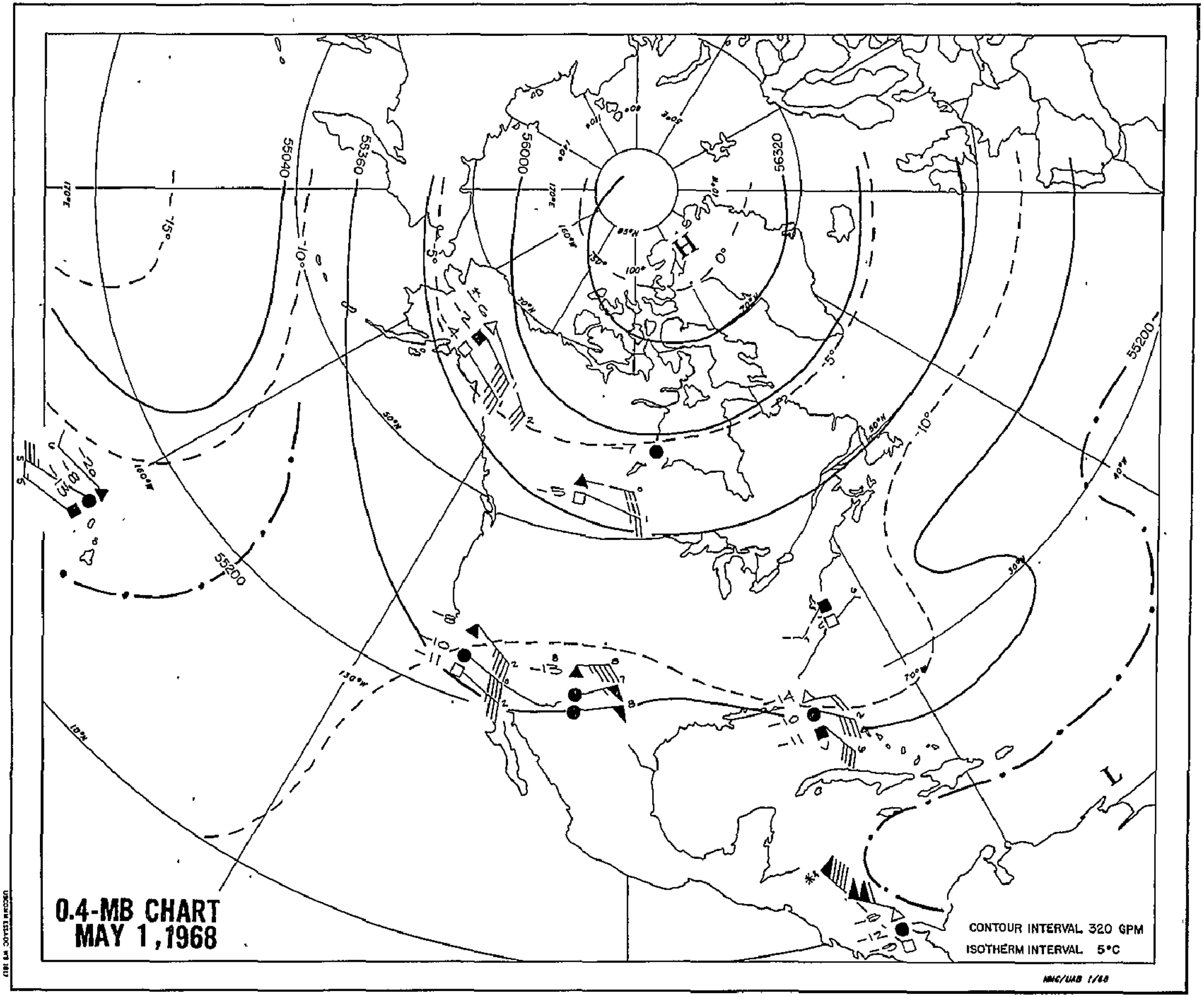

5-MB CHART
APR 24,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
36160
35840
36480
35520
36000
-20°
-25°
-30°
-35°
H
L


2-MB CHART
APR 24,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
42240
42560
42880
43200
-5°
-10°
-15°
-20°
H
L

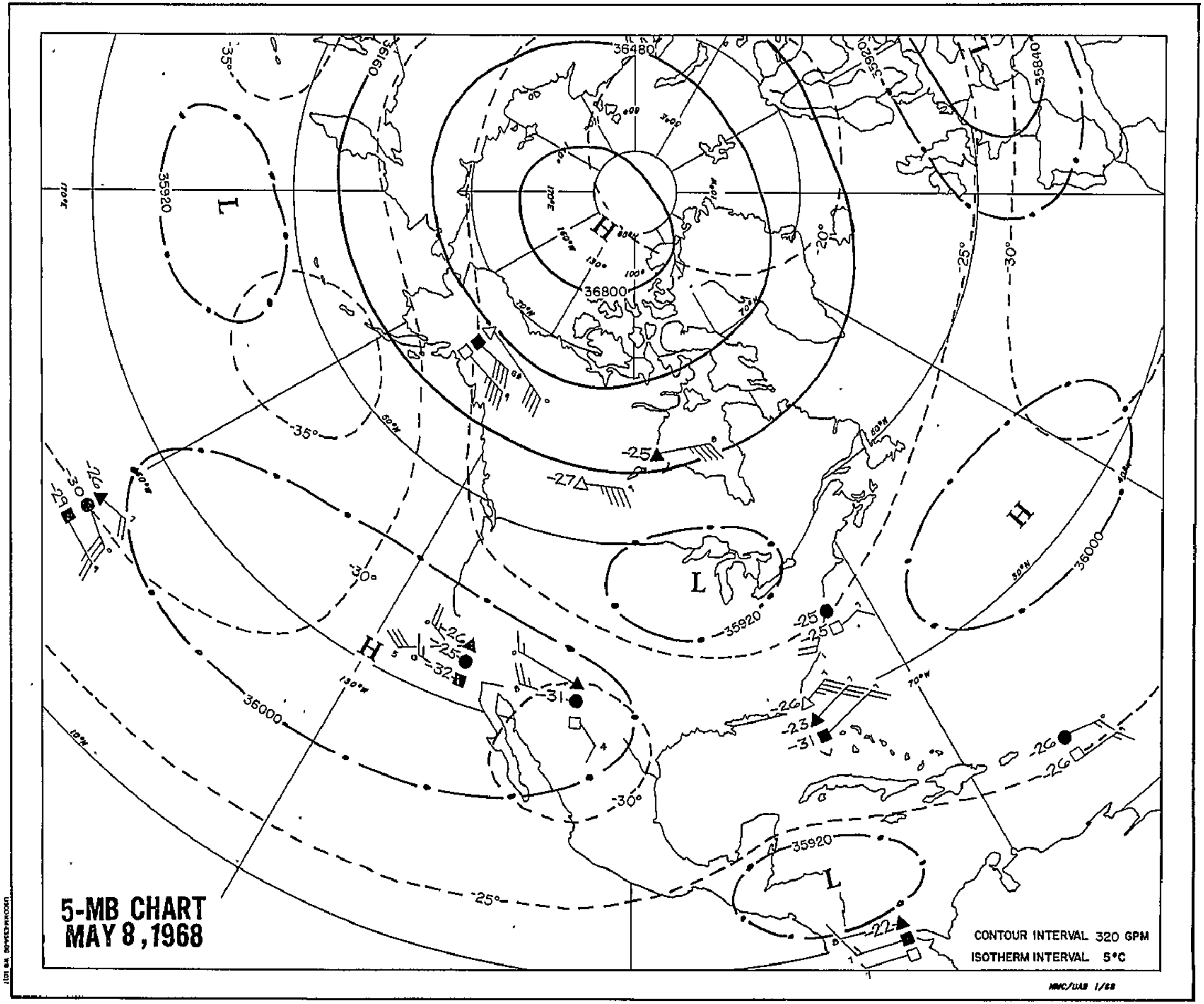

0.4-MB CHART
APR 24,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
L
56000
55680
55360
55040
55520
-10°
-15°
-20°
NMC/UAB 1/68

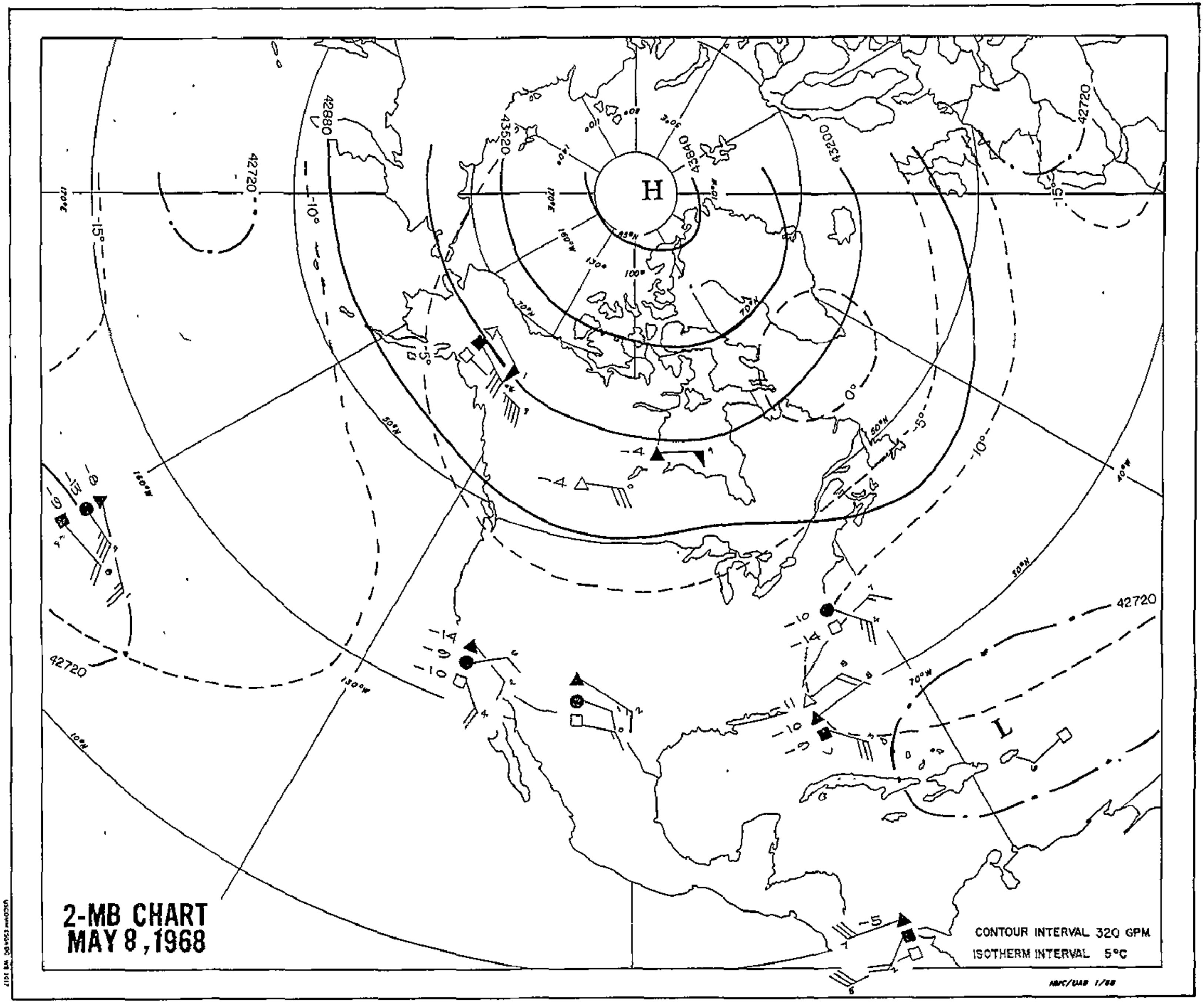

5-MB CHART
MAY 1, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
36480
36800
36160
36000
35840
35920
-20°
-25°
-30°
-35°
-40°
H
L
NMC/UAB 1/68

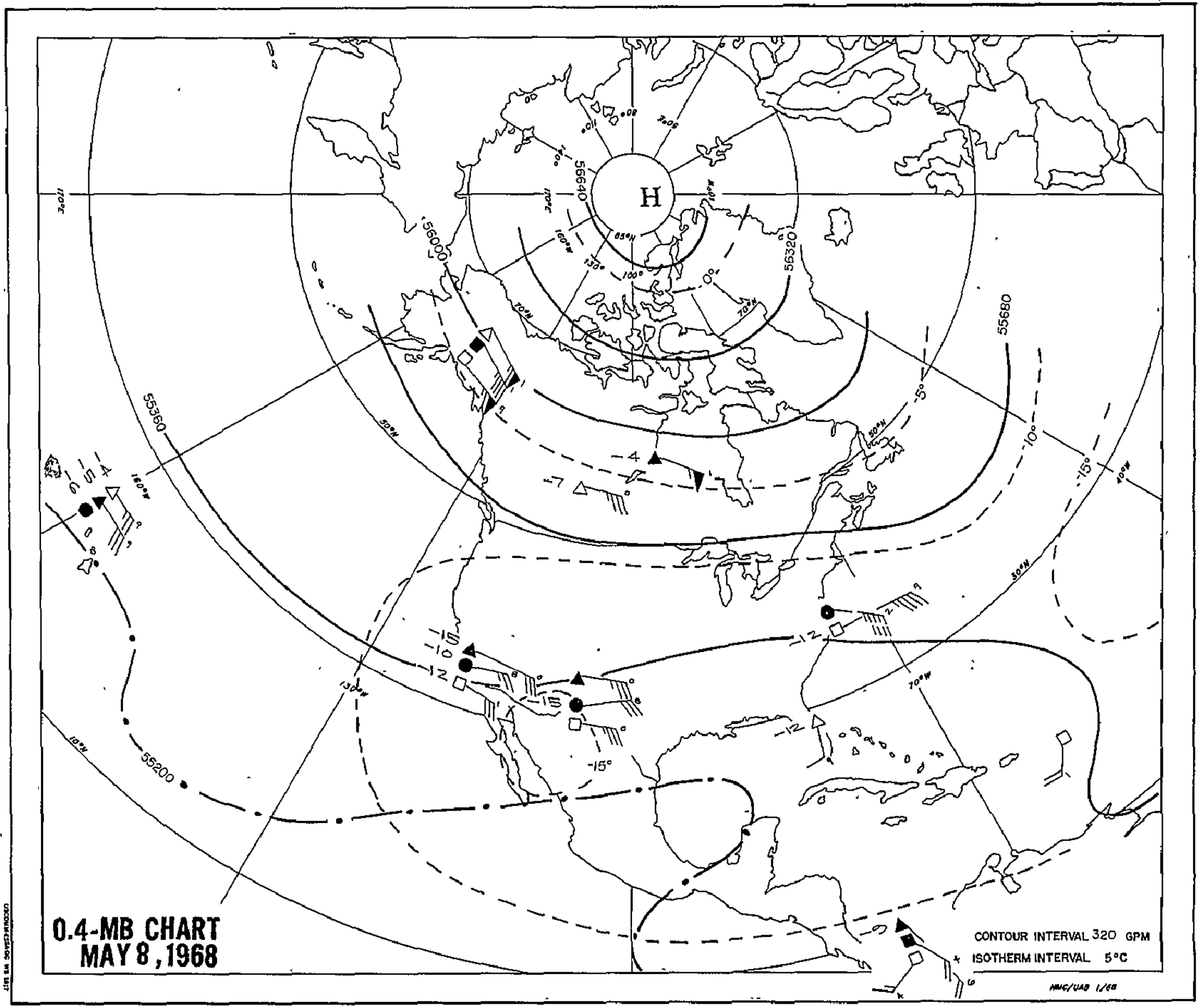

2-MB CHART
MAY 1, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
42560
42880
43200
43520
42800
-5°
-10°
-15°
0°
H
L



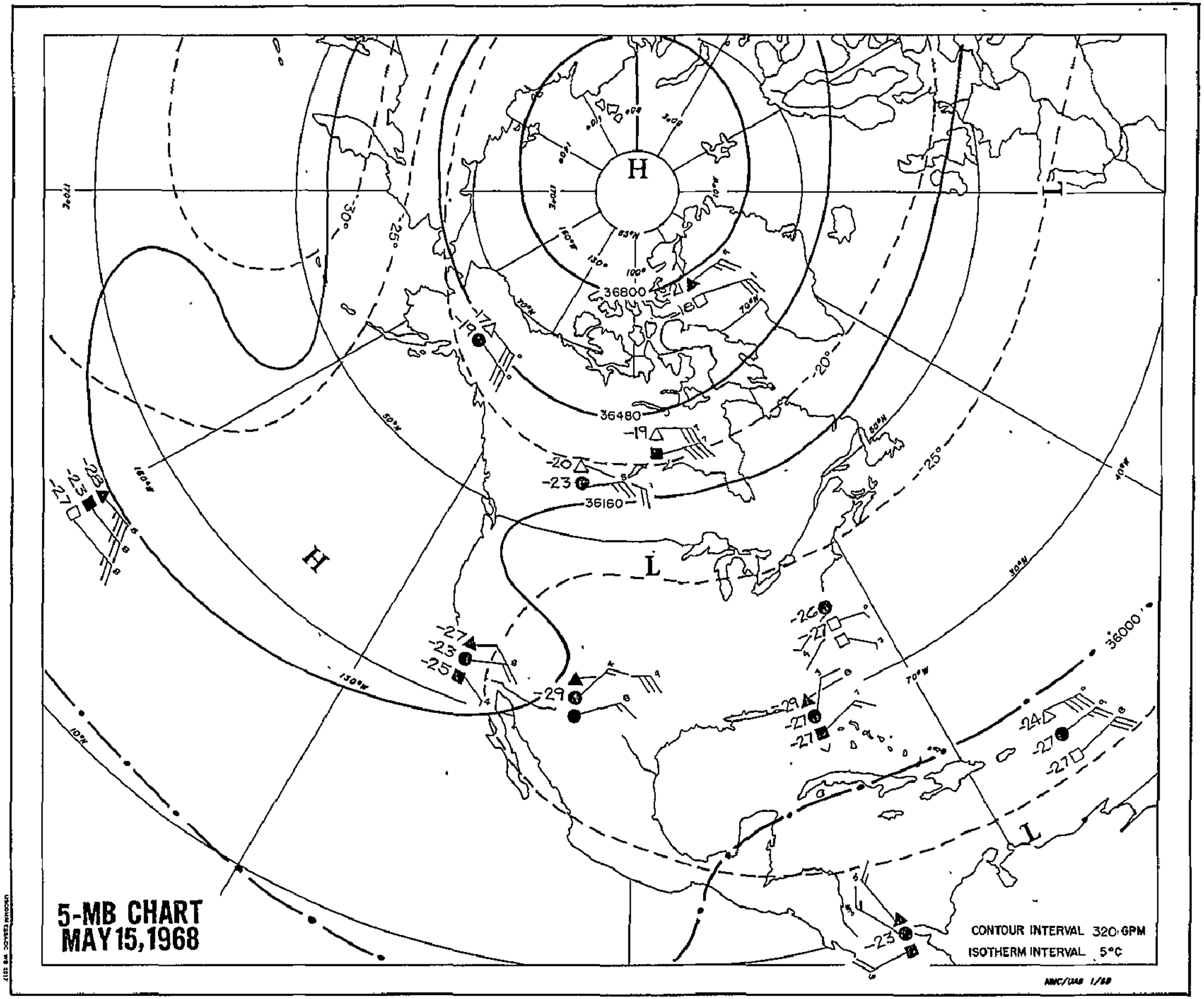
0.4-MB CHART
MAY 1, 1968


5-MB CHART
MAY 8, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
36480
36800
36160
35920
36000
35840
-35°
-30°
-25°
-20°
H
L

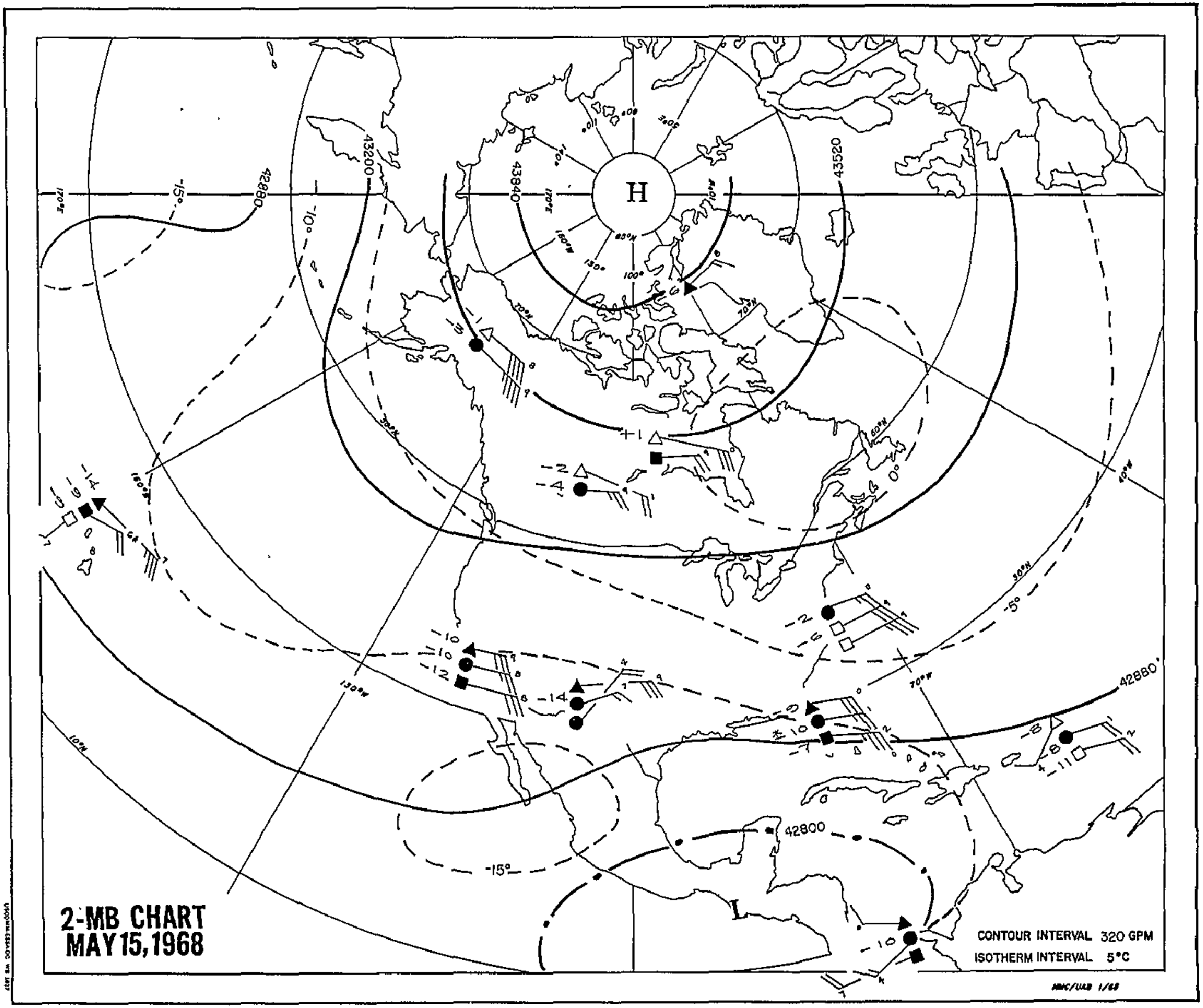

2-MB CHART
MAY 8, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
L
42720
42880
43200
43520
43840
-15°
-10°
-5°
0°

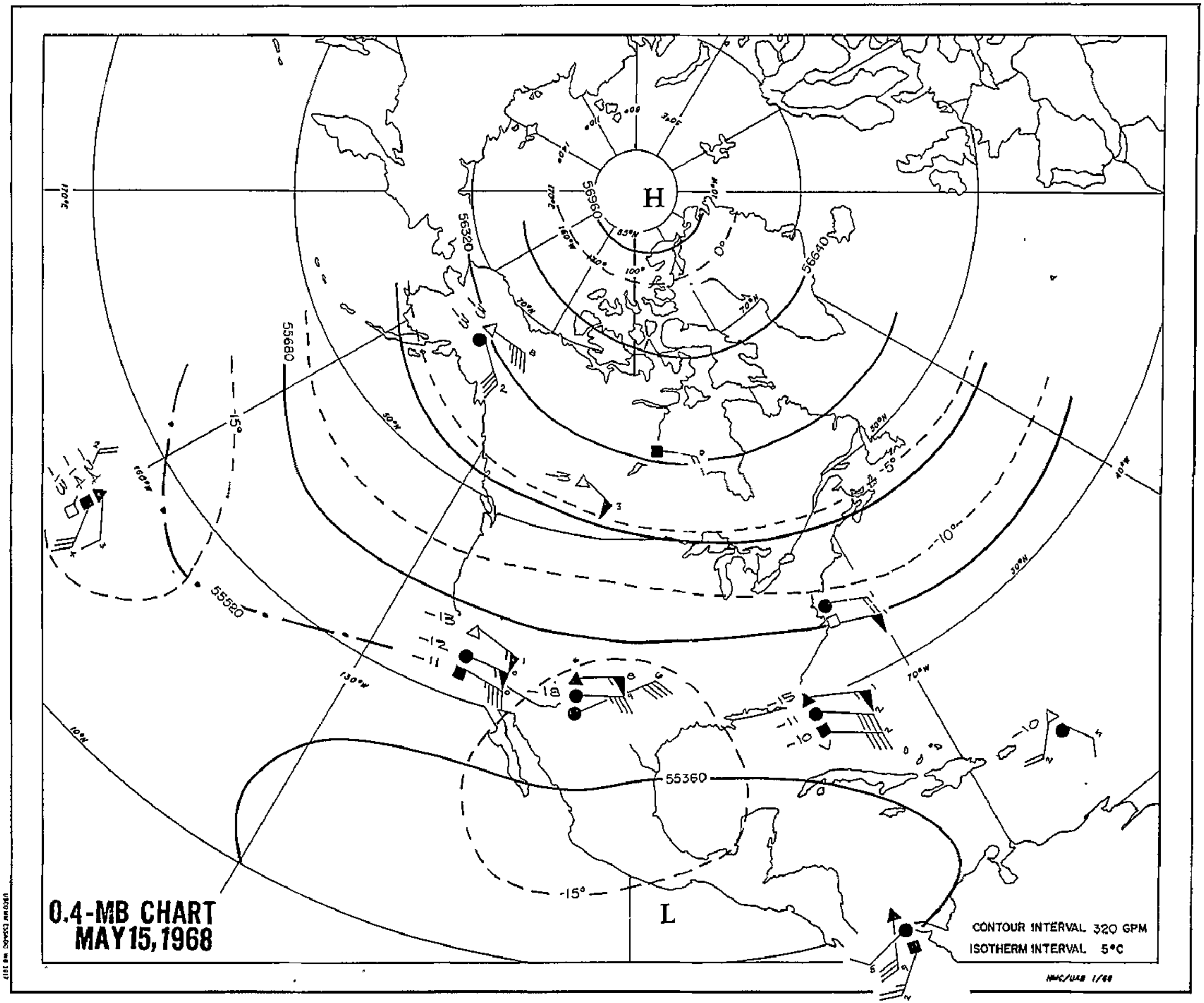


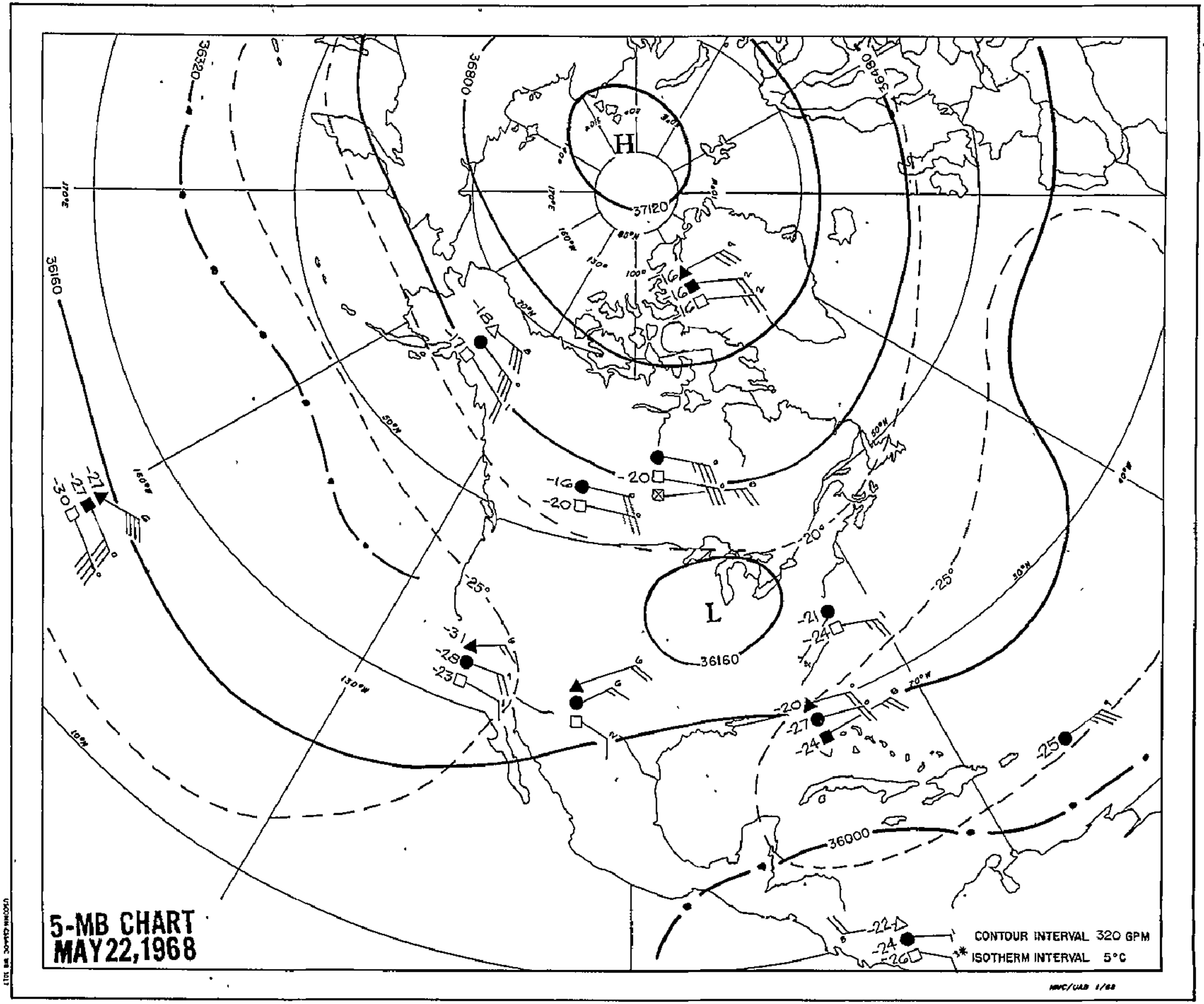
0.4-MB CHART
MAY 8, 1968

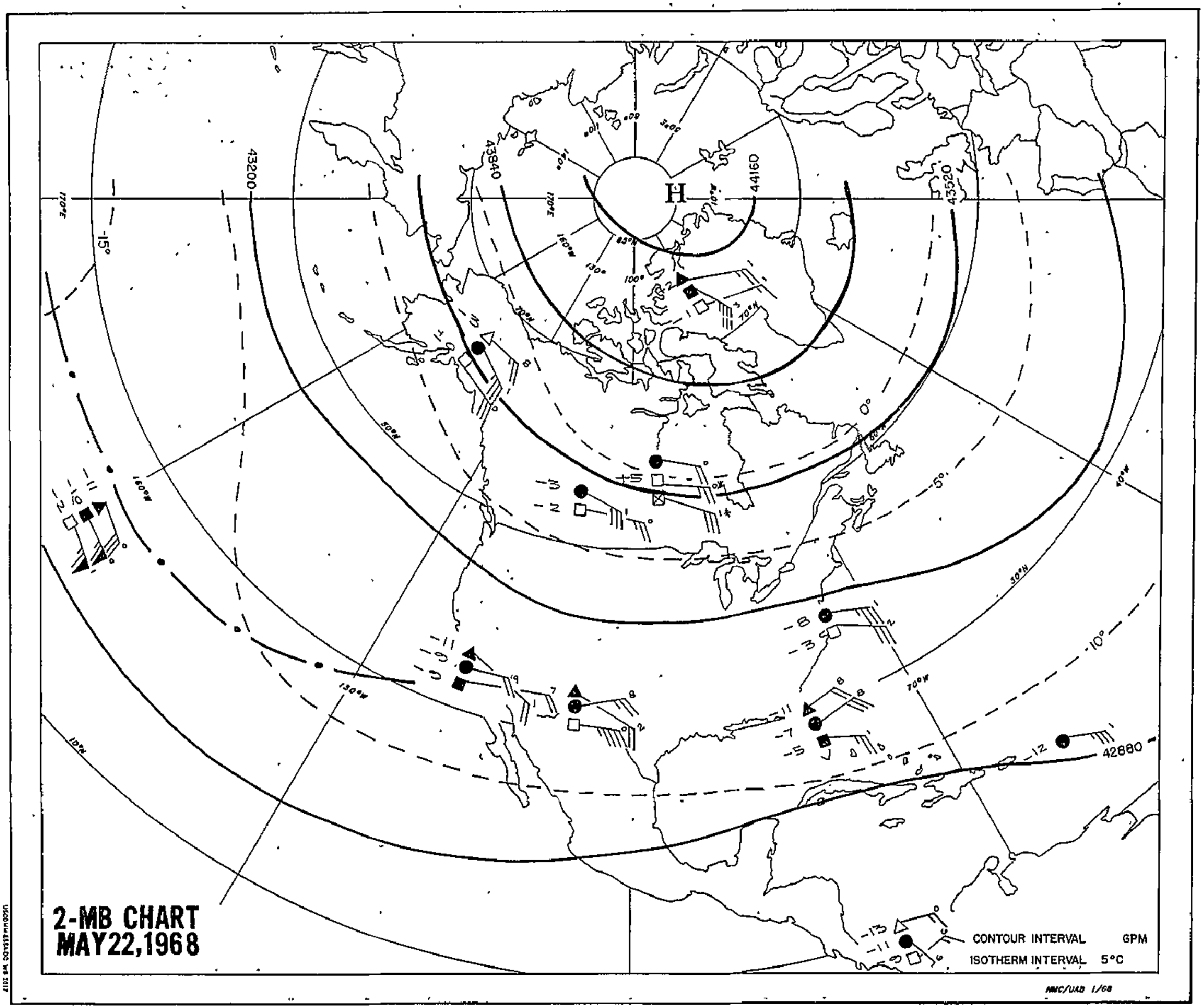


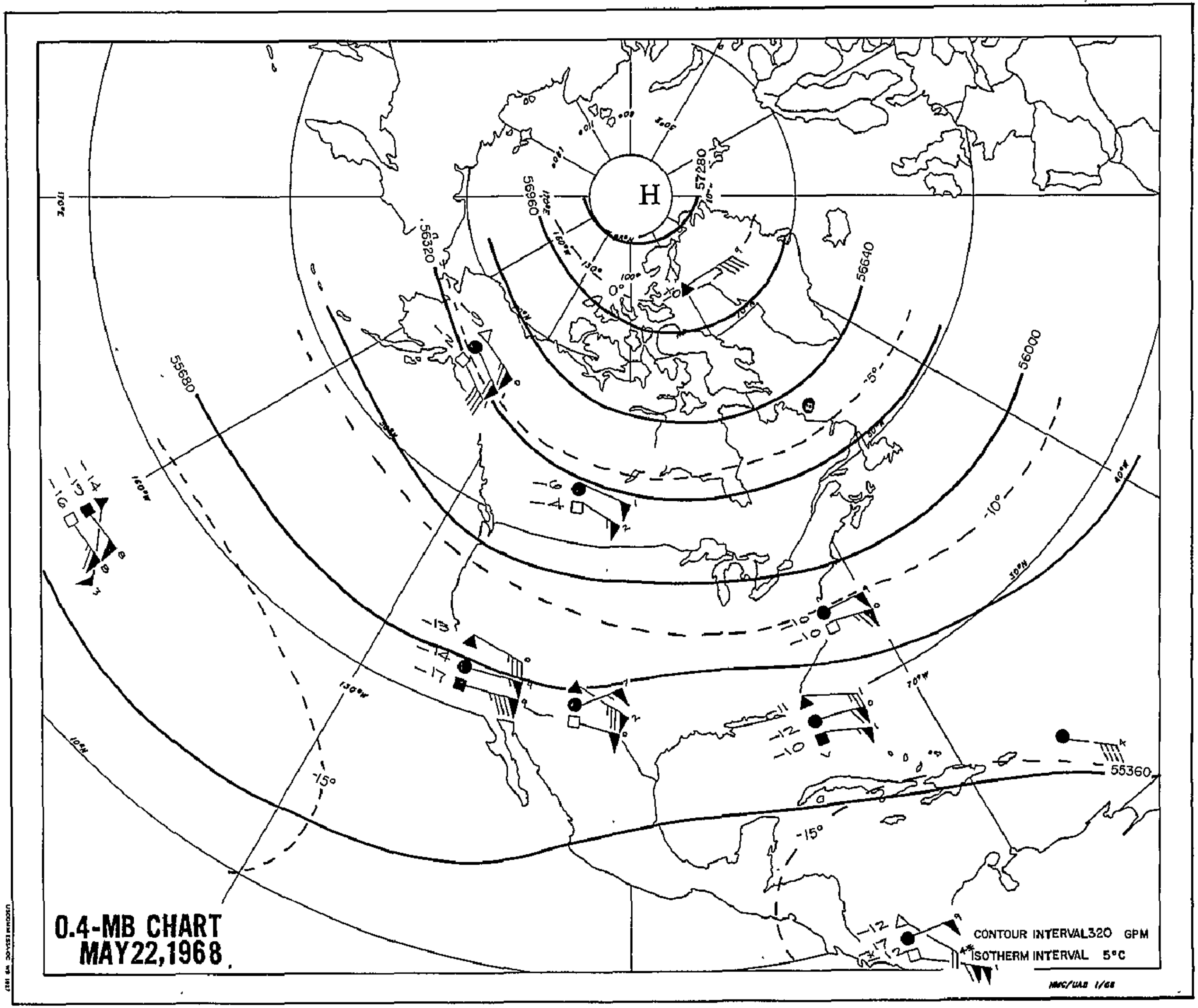
5-MB CHART
MAY 15,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
H
L
L
L
36800
36480
36160
36000
-30°
-25°
-20°
-25°
NMC/UAB 1/68

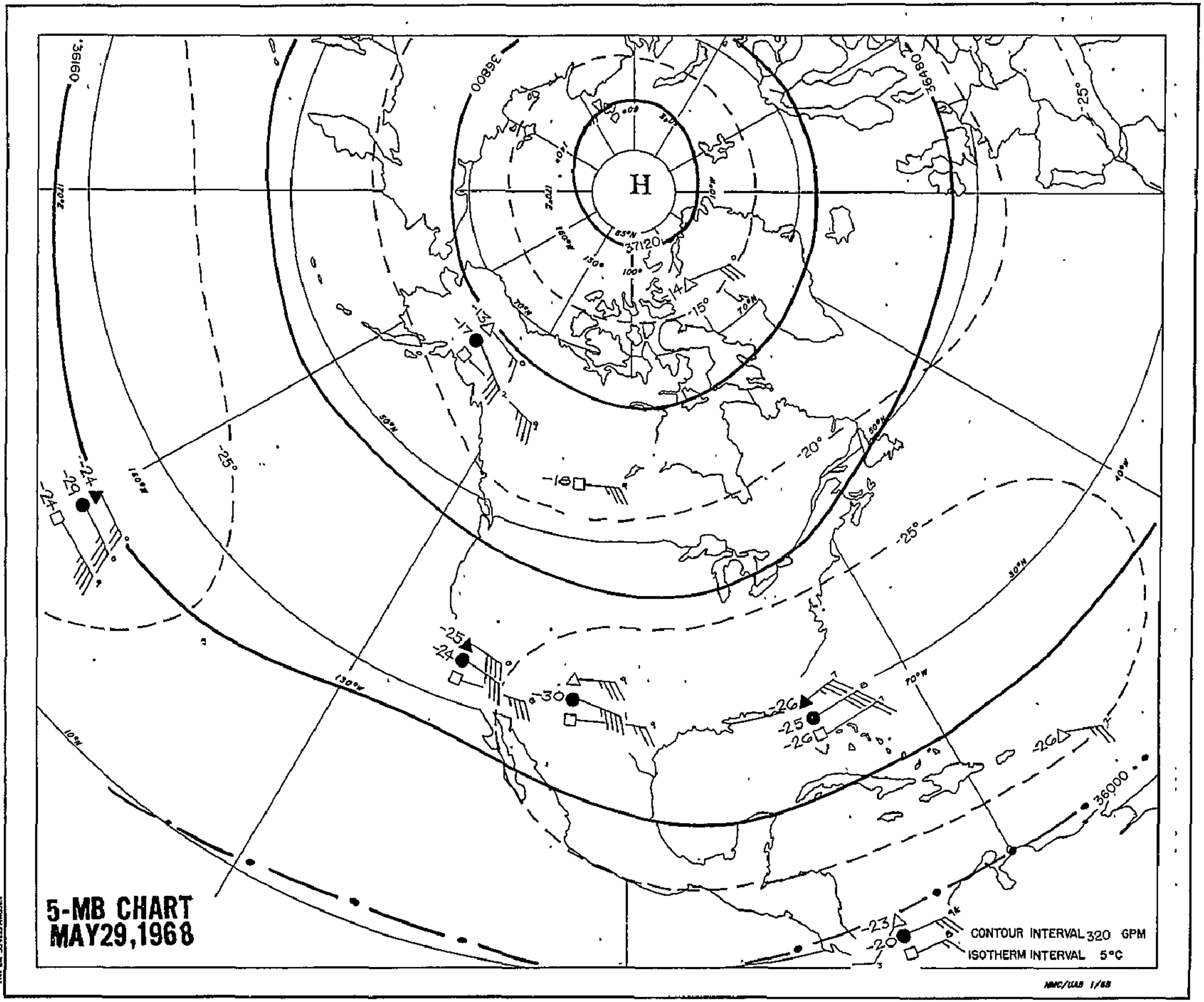

2-MB CHART
MAY 15,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
L
43840
43520
43200
42880
42800
-15°
-10°
0°
-5°

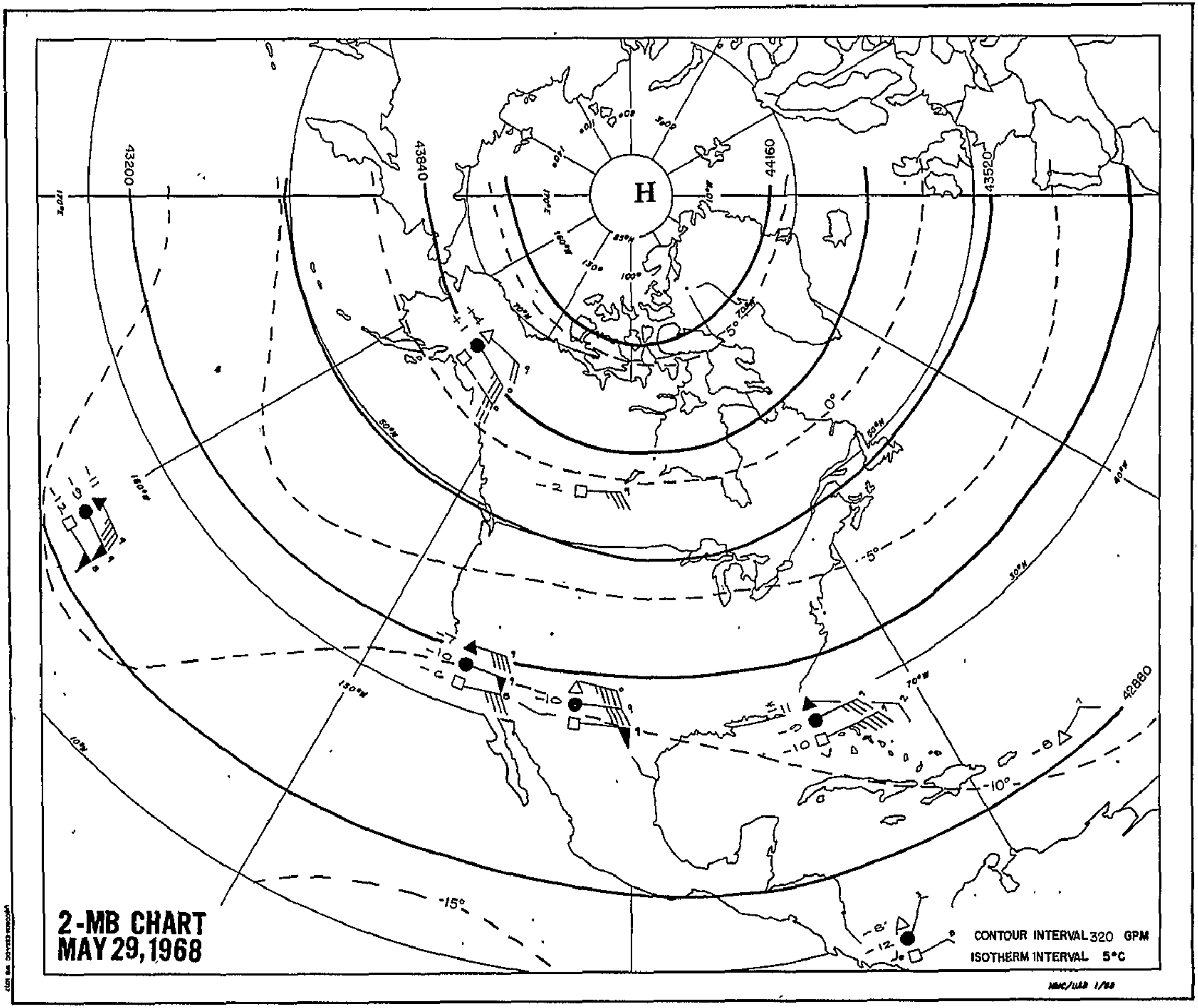

0.4-MB CHART
MAY 15, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
L
56960
56640
56320
55680
55520
55360
-15°
-10°
-5°
0°

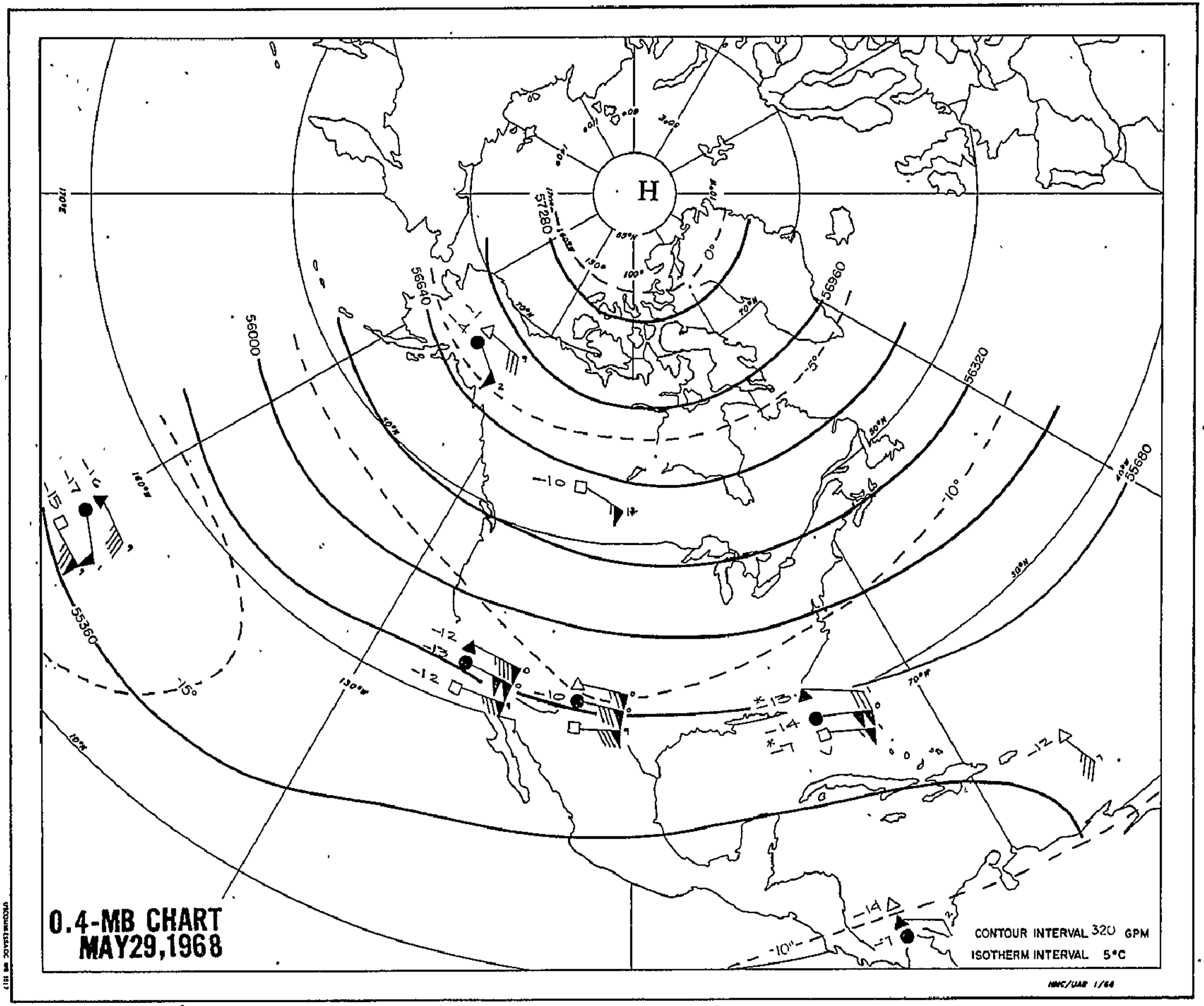

5-MB CHART
MAY 22,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
L
37120
36800
36480
36320
36160
36000
-20°
-25°

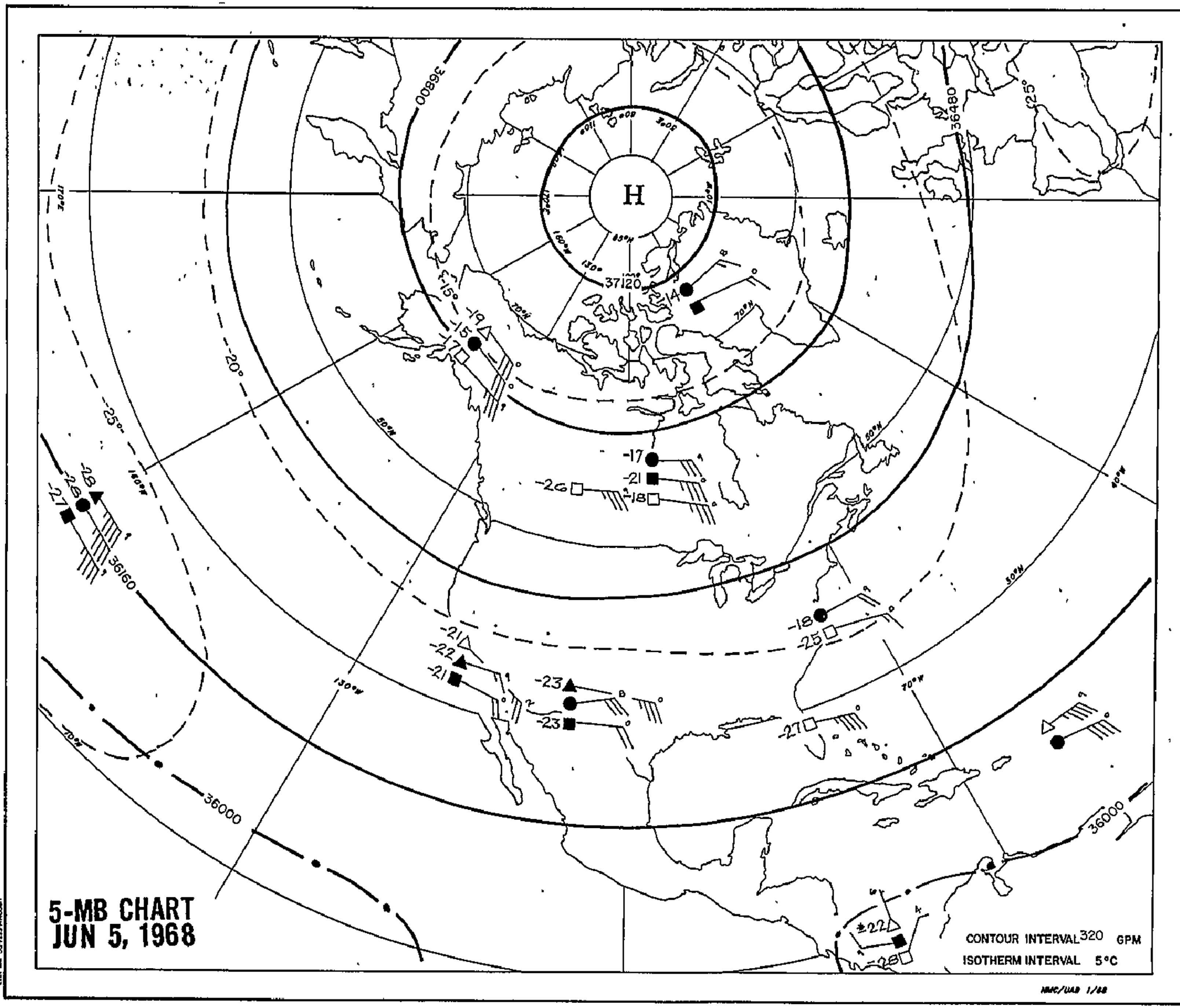

2-MB CHART
MAY22,1968
CONTOUR INTERVAL GPM
ISOTHERM INTERVAL 5°C
NMC/UAB 1/68
H
43200
43840
44160
43520
42880
-15°
0°
-5°
-10°

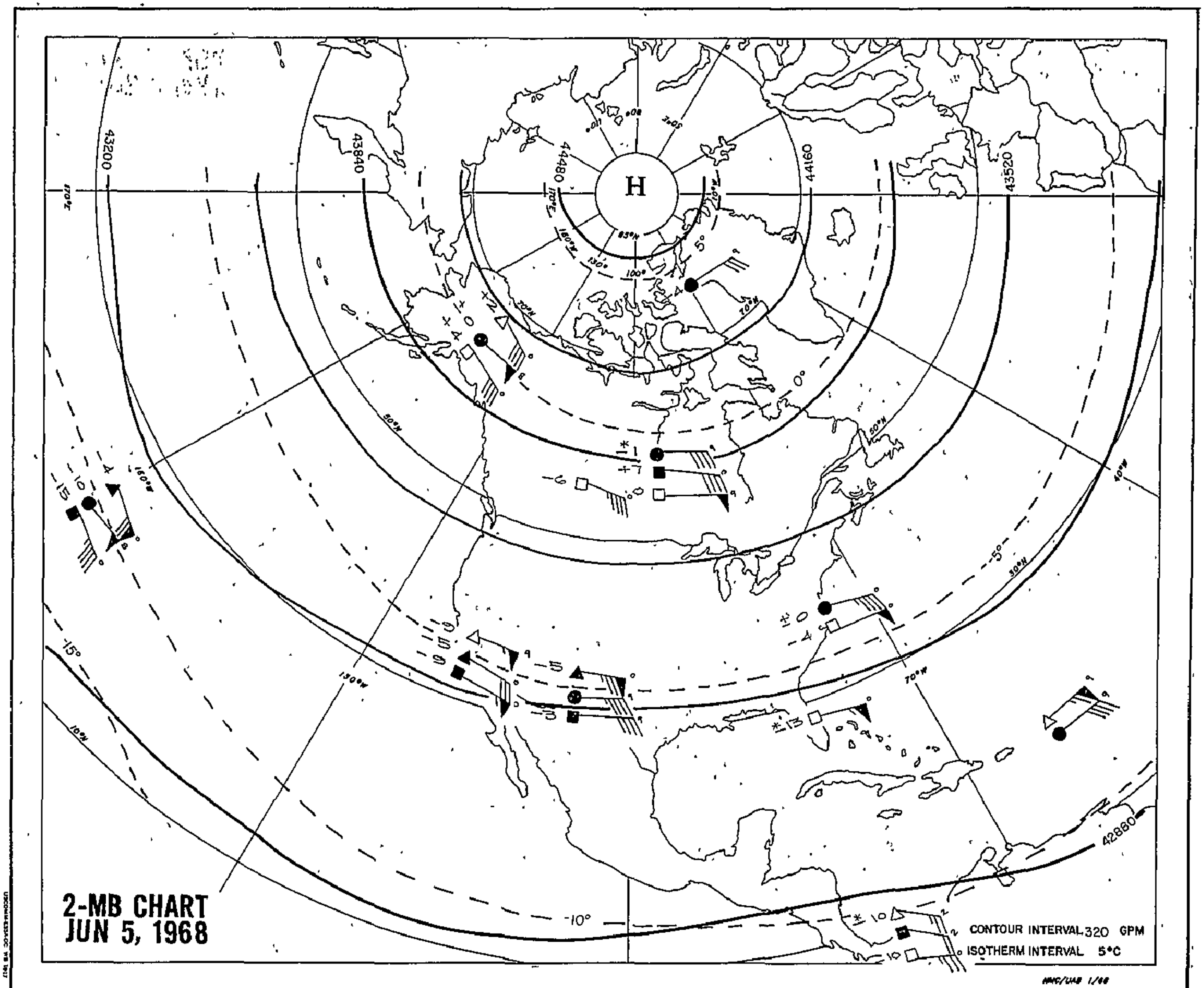

0.4-MB CHART
MAY22,1968
CONTOUR INTERVAL320 GPM
ISOTHERM INTERVAL 5°C
H
57280
56960
56640
56320
56000
55680
55360
0°
-5°
-10°
-15°
-15°

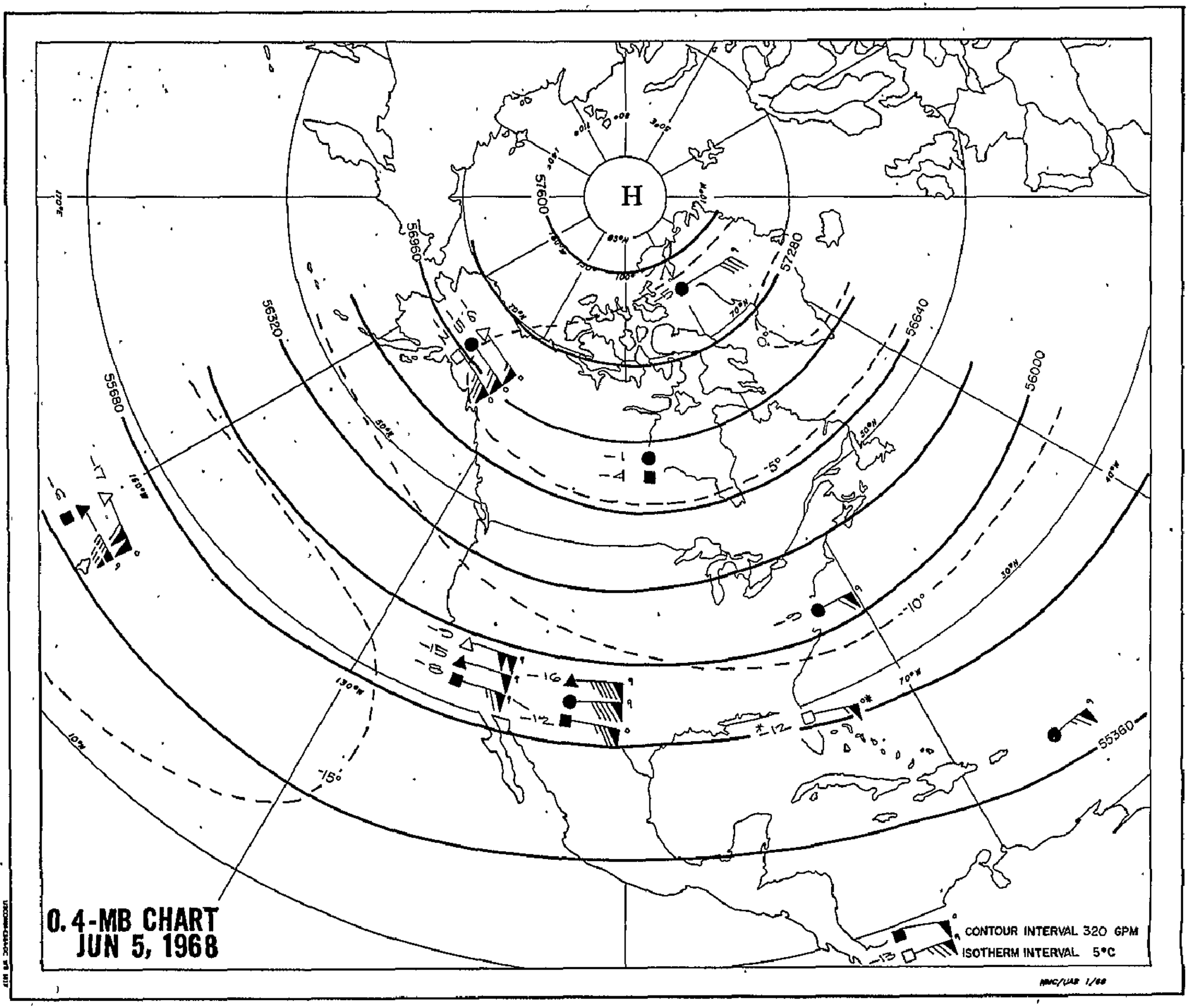

5-MB CHART
MAY29,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
37120
36800
36480
36160
36000
-15°
-20°
-25°
-25°
-25°
NMC/UAB 1/68

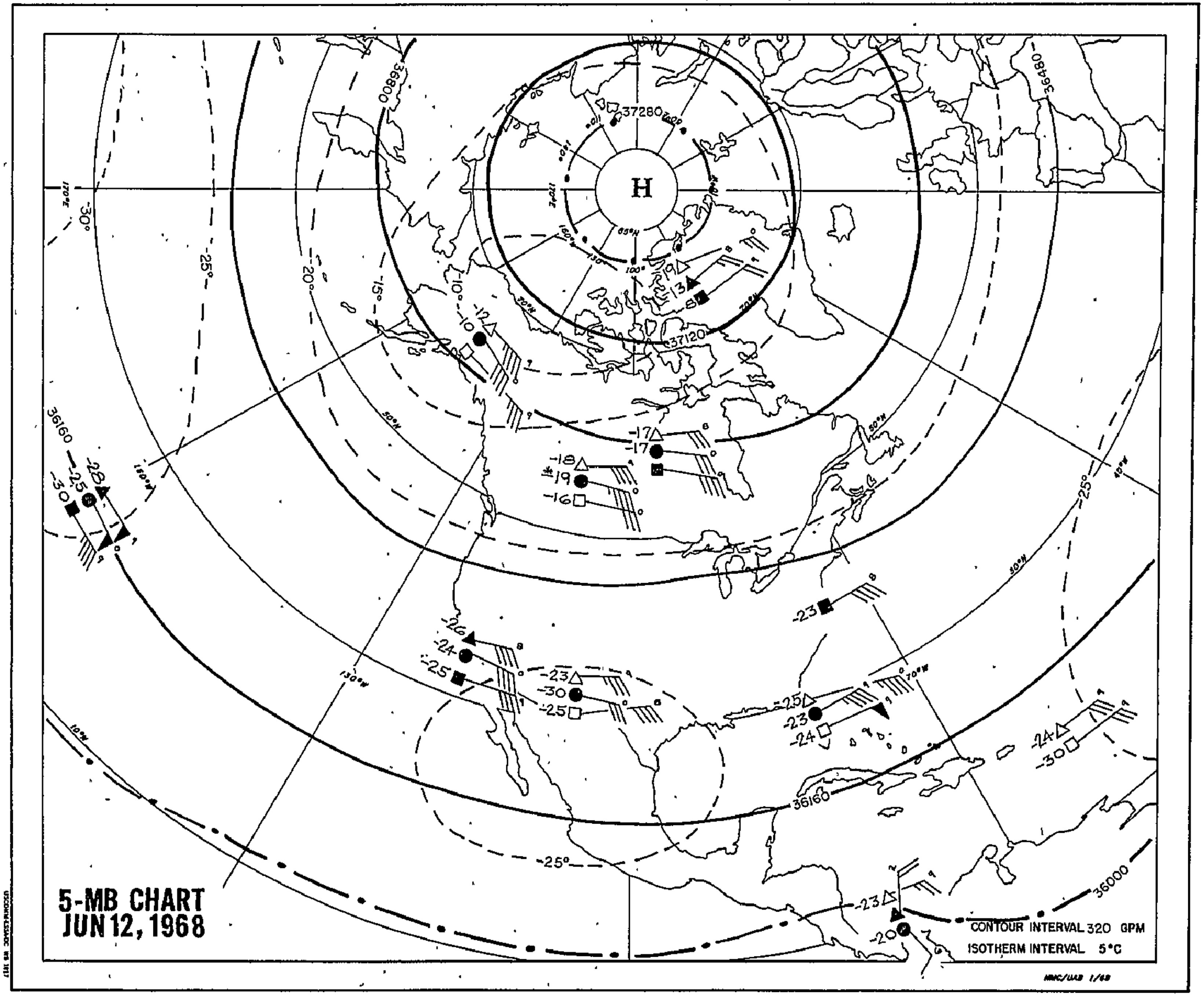

2-MB CHART
MAY 29, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
43200
43840
44160
43520
42880
0°
-5°
-10°
-15°

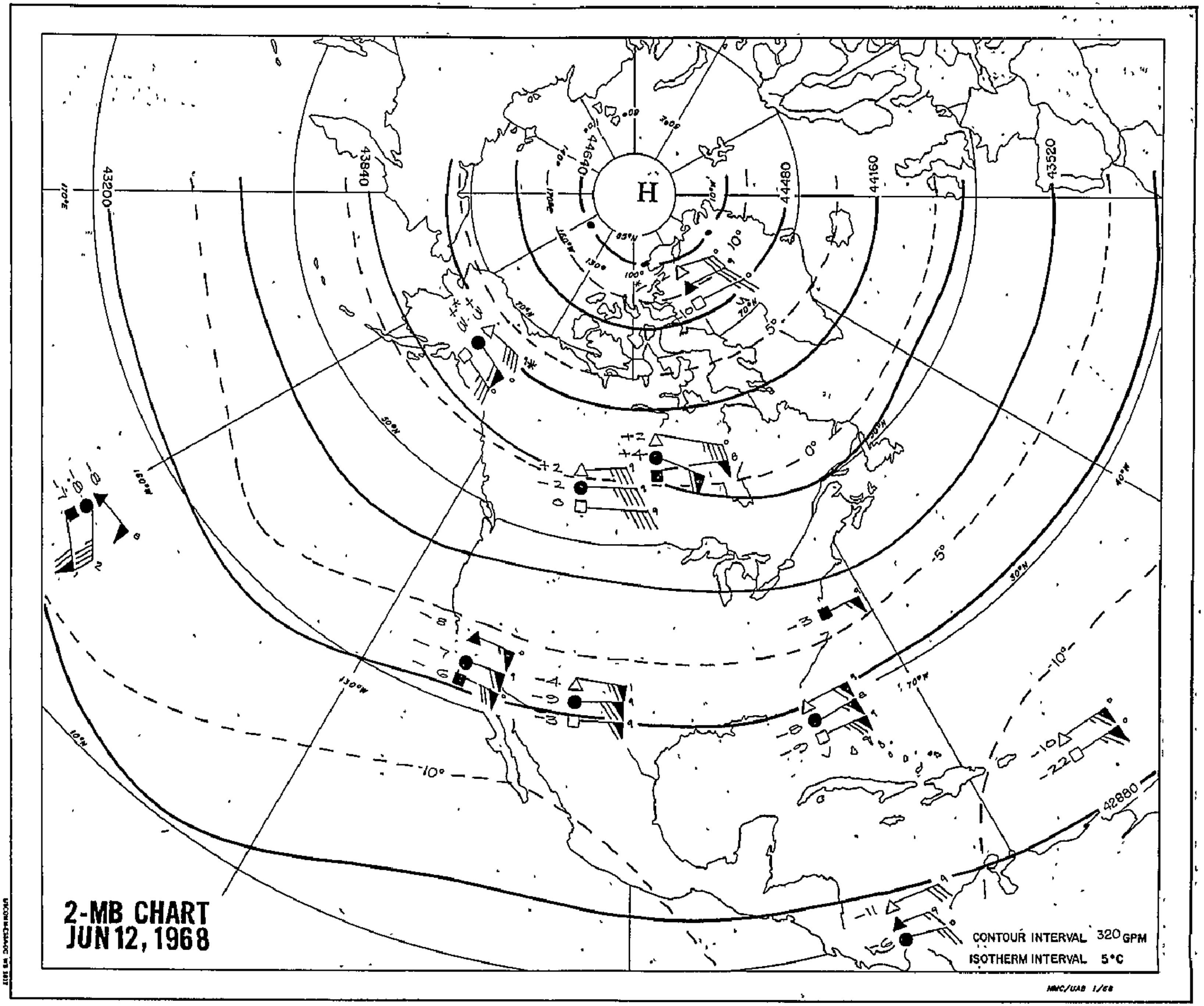

0.4-MB CHART
MAY29,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
57280
56960
56640
56320
56000
55680
55360
0°
-5°
-10°
-15°
10°


5-MB CHART
JUN 5, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
37120
36800
36480
36160
36000
-15°
-20°
-25°
-25°

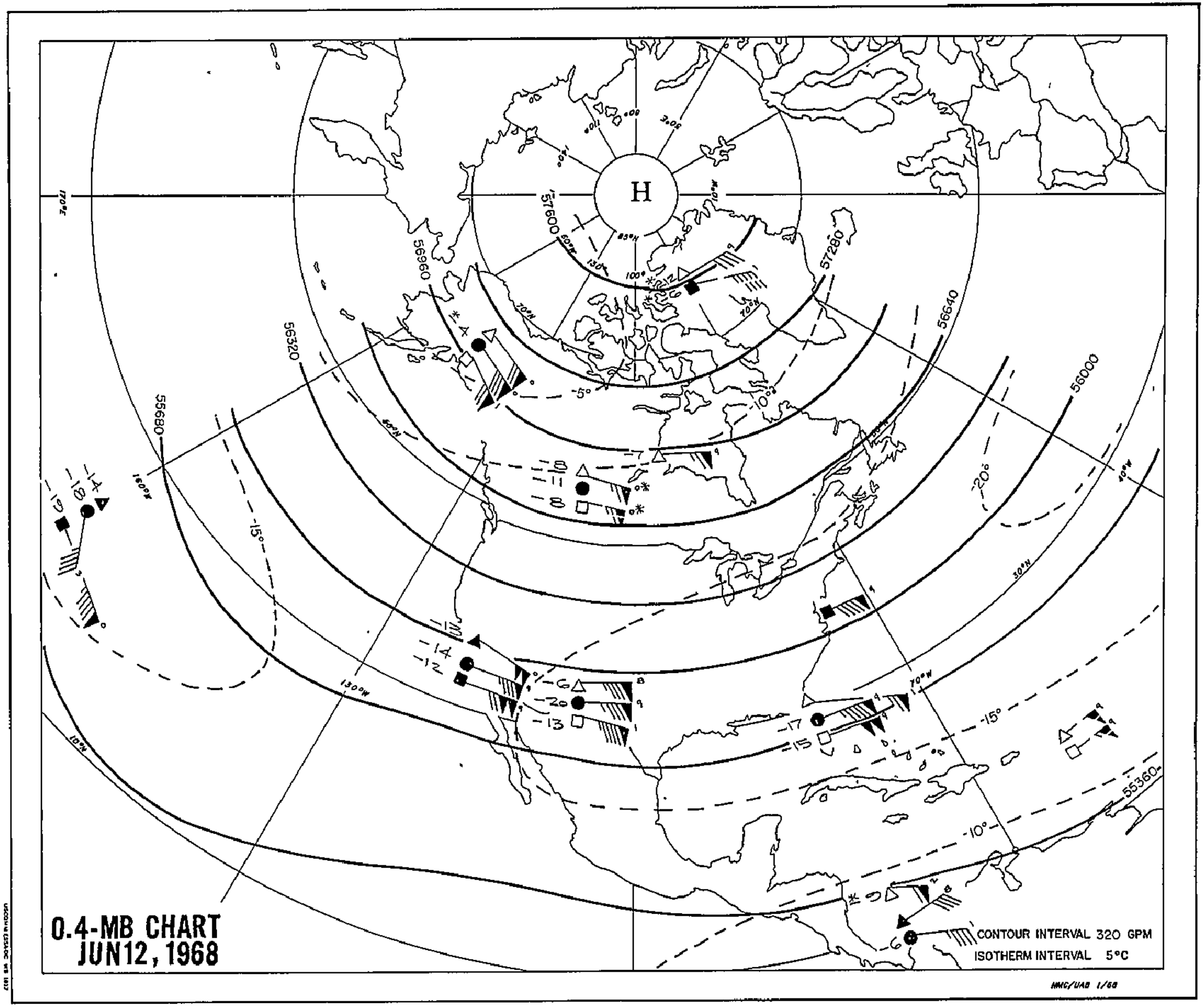

2-MB CHART
JUN 5, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
43200
43840
44480
44160
43520
42880
5°
0°
-5°
-10°
-15°

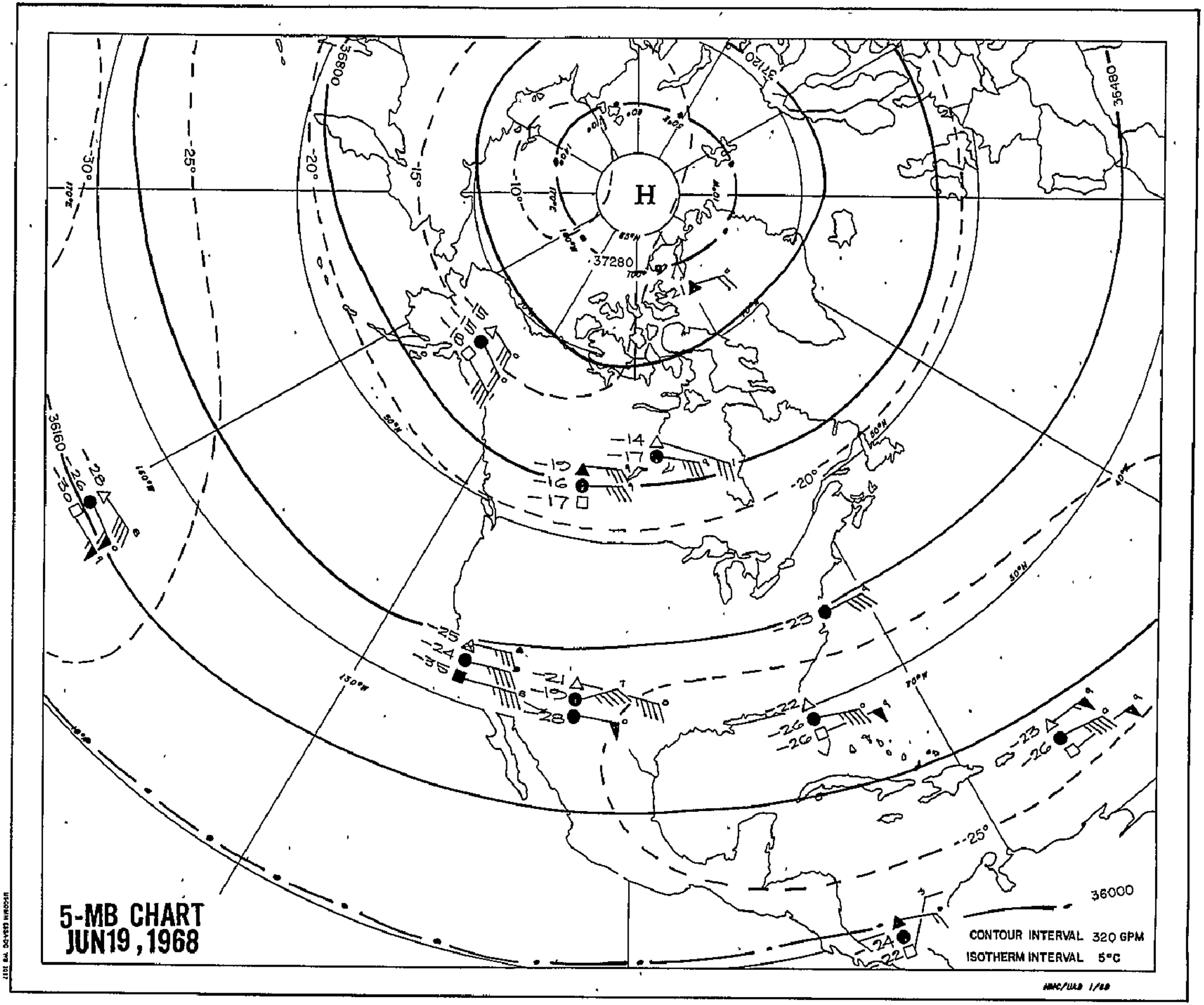

0.4-MB CHART
JUN 5, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
57600
56960
57280
56320
56640
55680
56000
55360
-5°
-10°
-15°

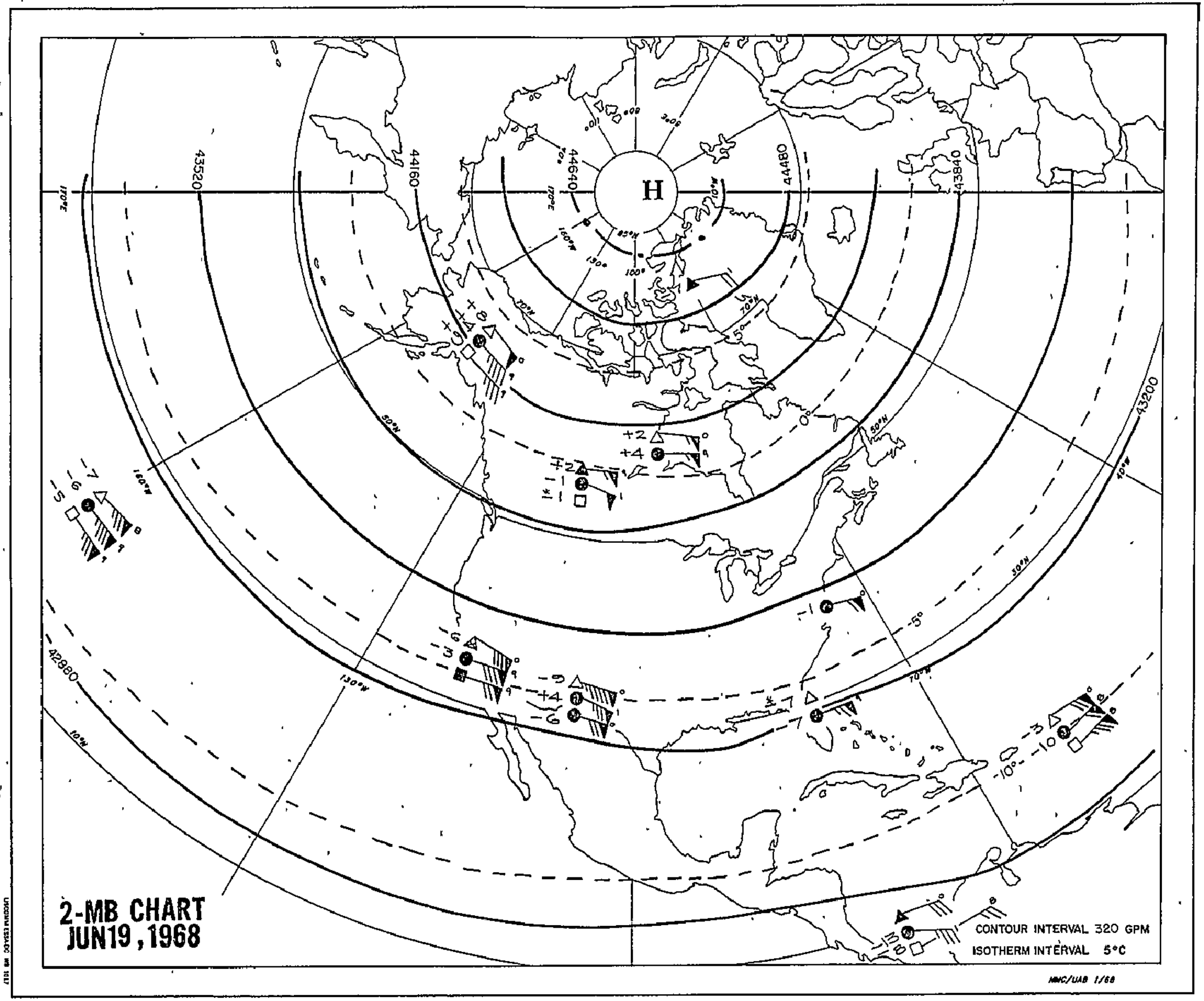

5-MB CHART
JUN 12, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
37280
37120
36800
36480
36160
36000
-30°
-25°
-20°
-15°
-10°

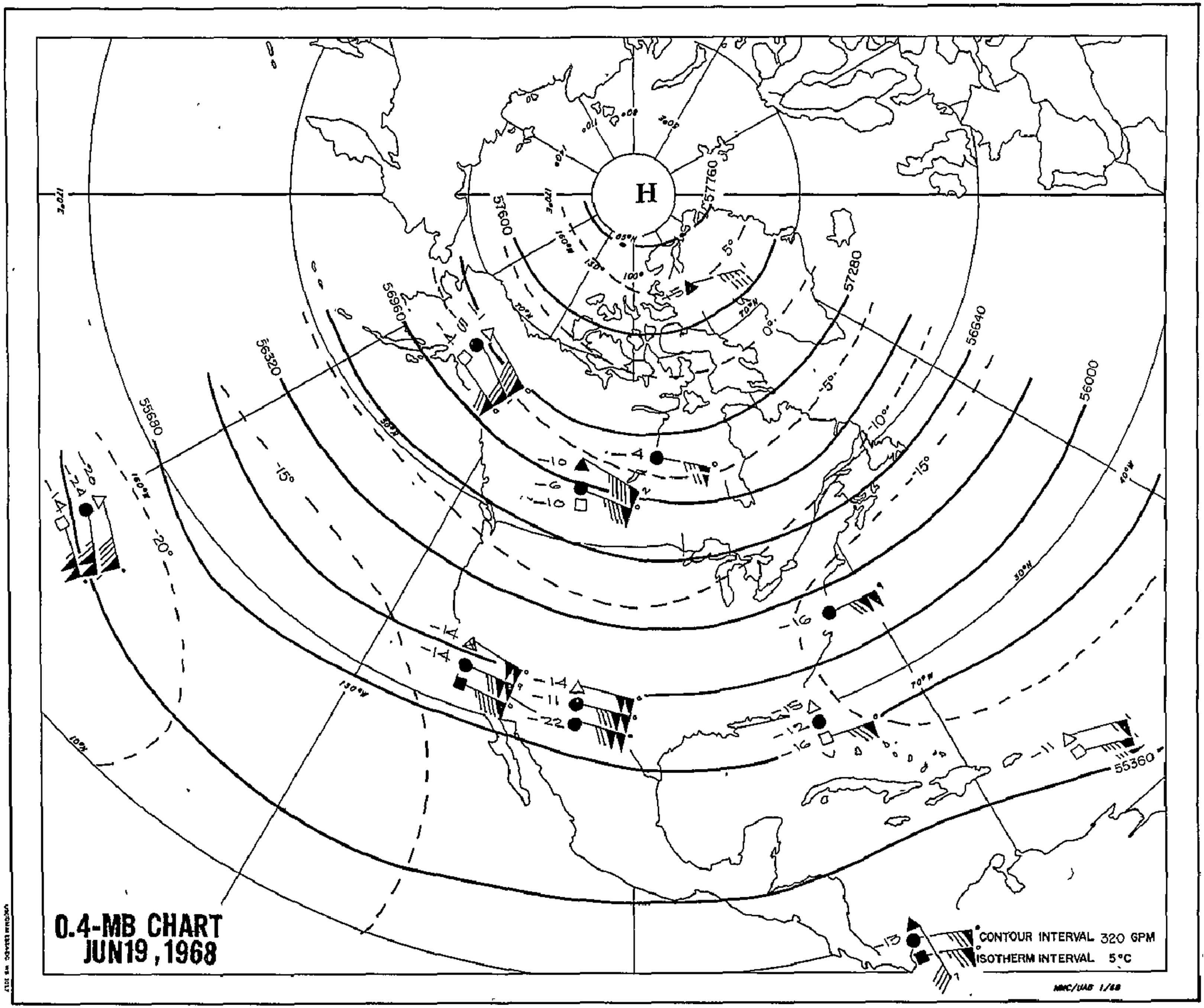


2-MB CHART
JUN 12, 1968

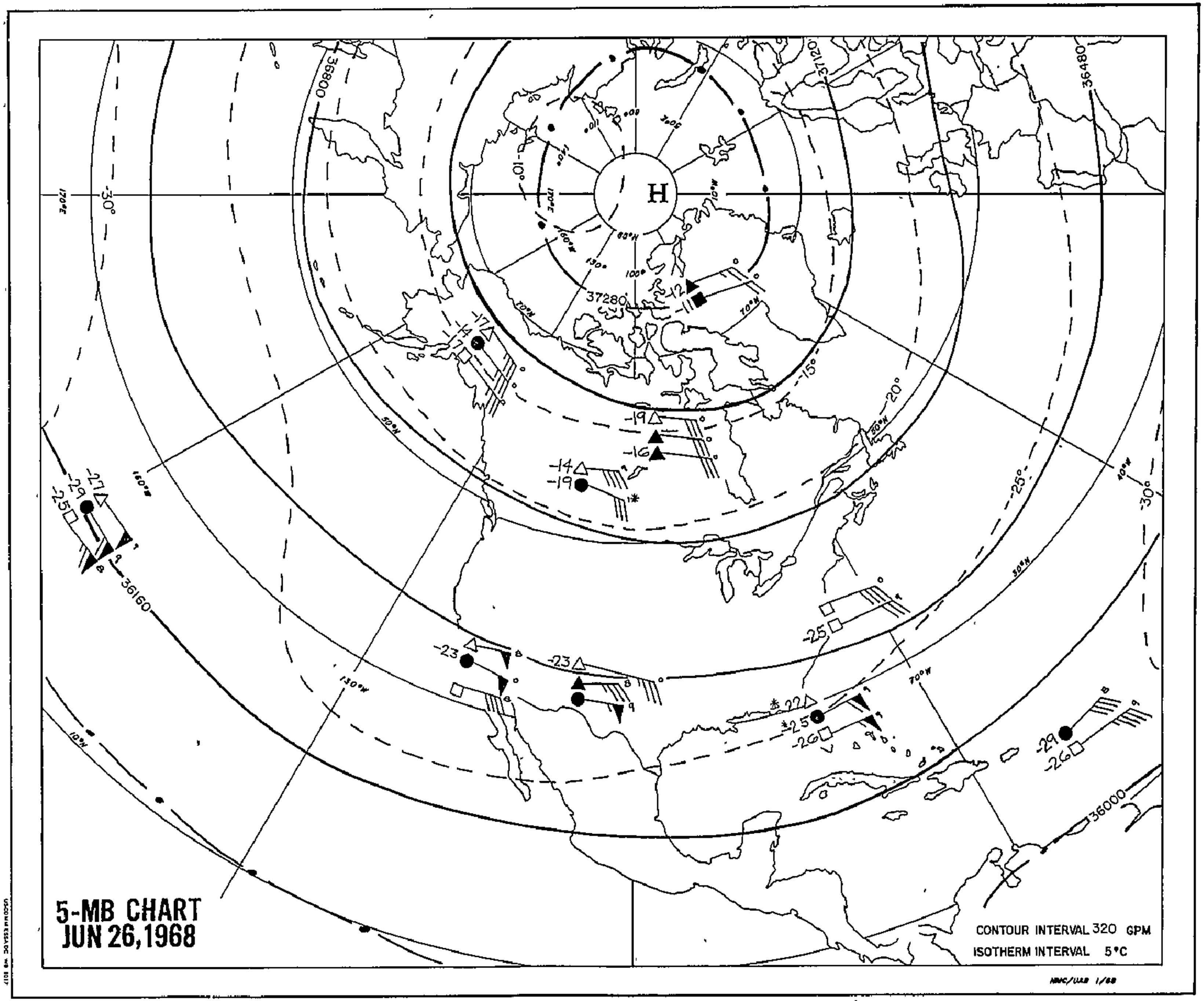

H
57600
57280
56960
56640
56320
56000
55680
55360
-5°
-10°
-15°
-20°
0.4-MB CHART
JUN12, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
NMC/UAB 1/68

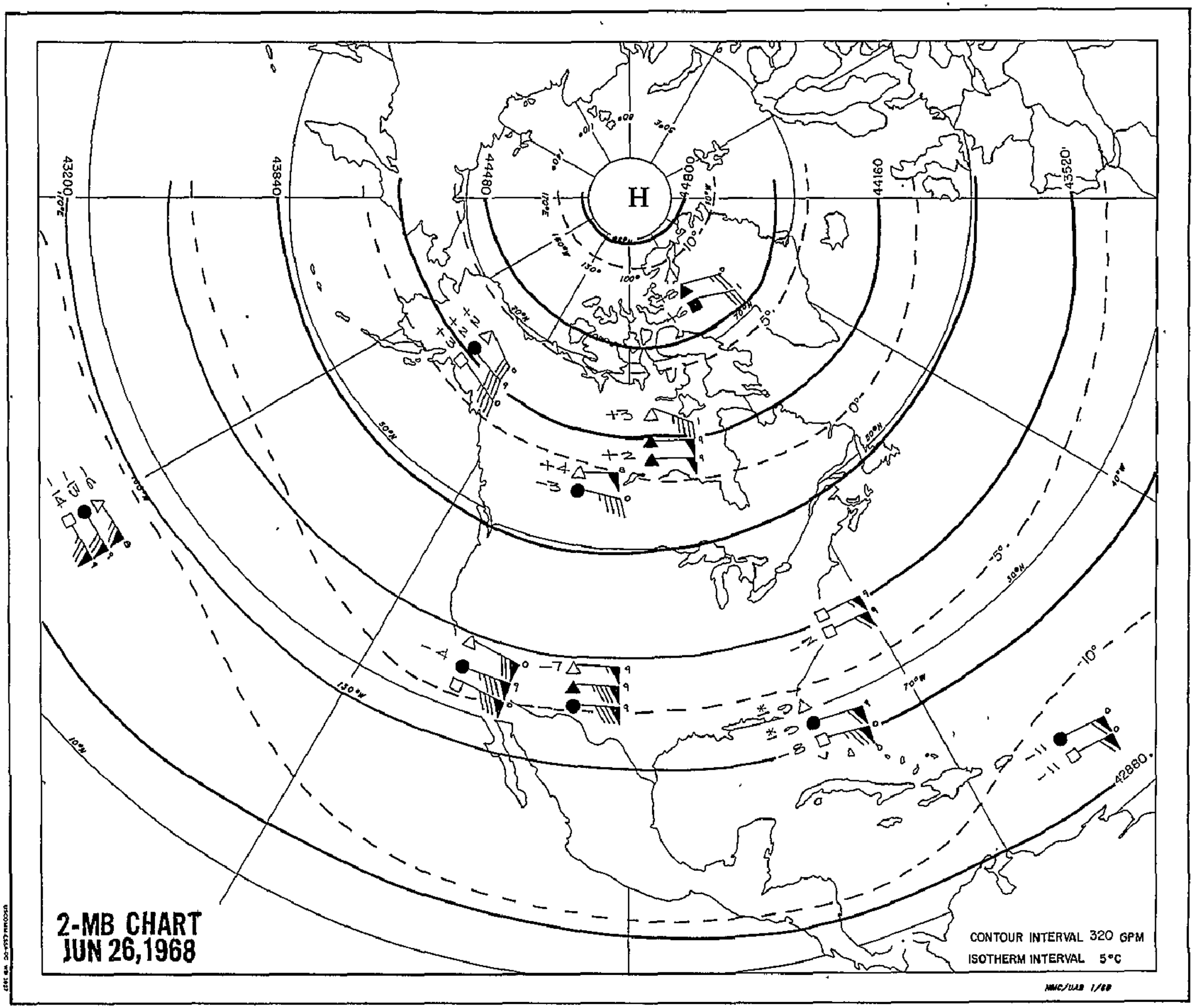

5-MB CHART
JUN19,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
37280
37120
36800
36480
36160
36000
-10°
-15°
-20°
-25°
-30°

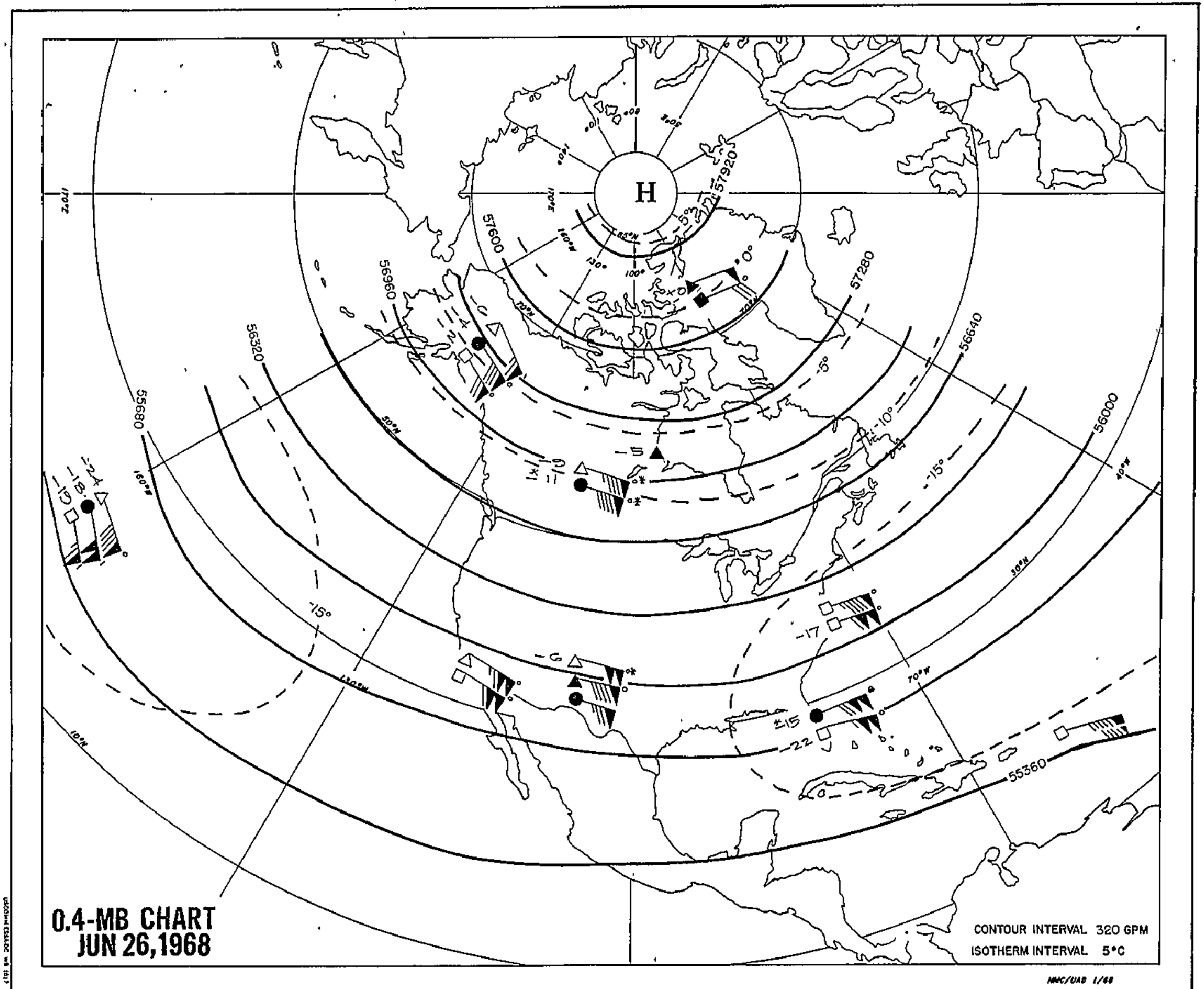

2-MB CHART
JUN19, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
44640
44480
44160
43840
43520
43200
42880
H
MMC/UAB 1/68

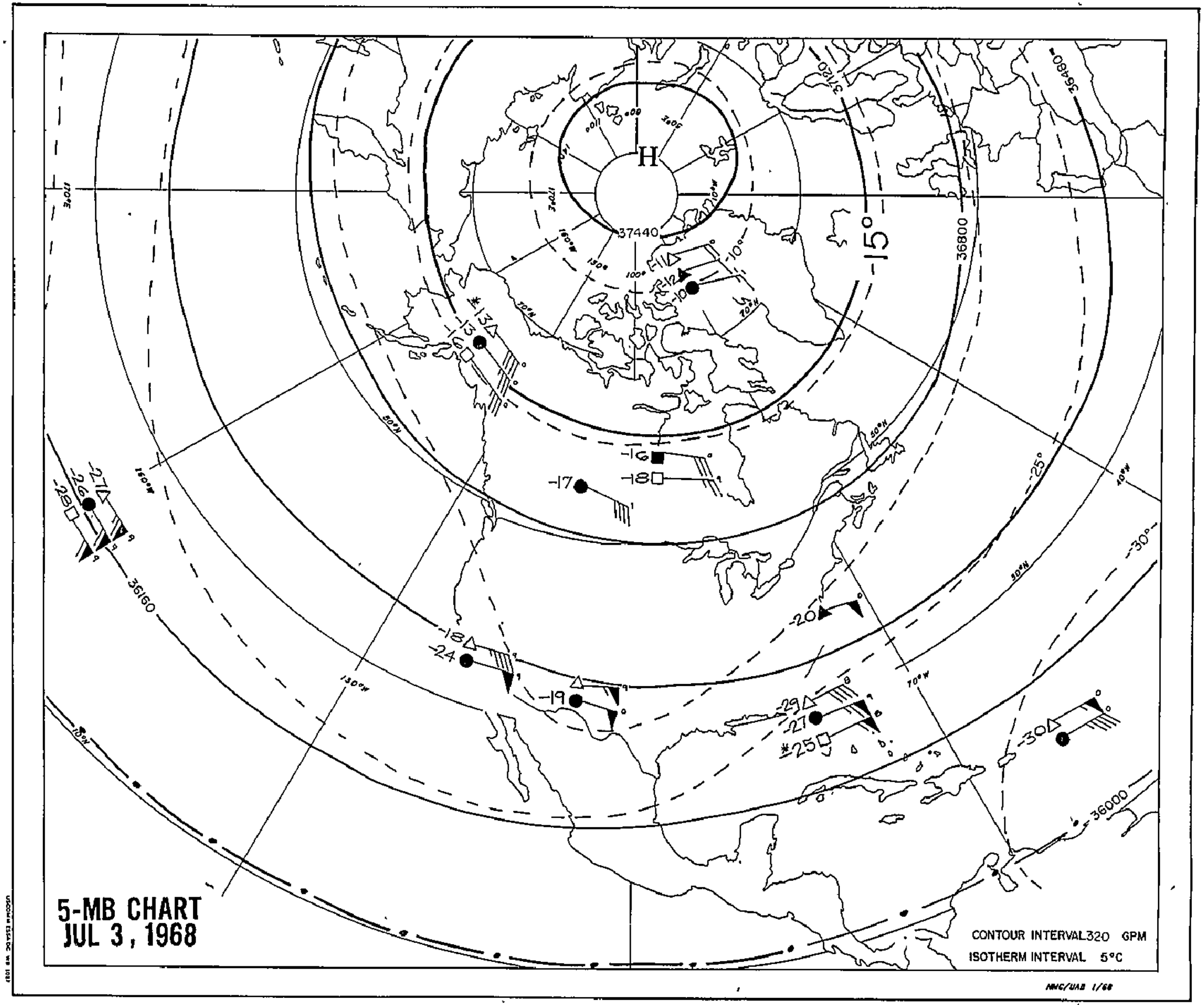


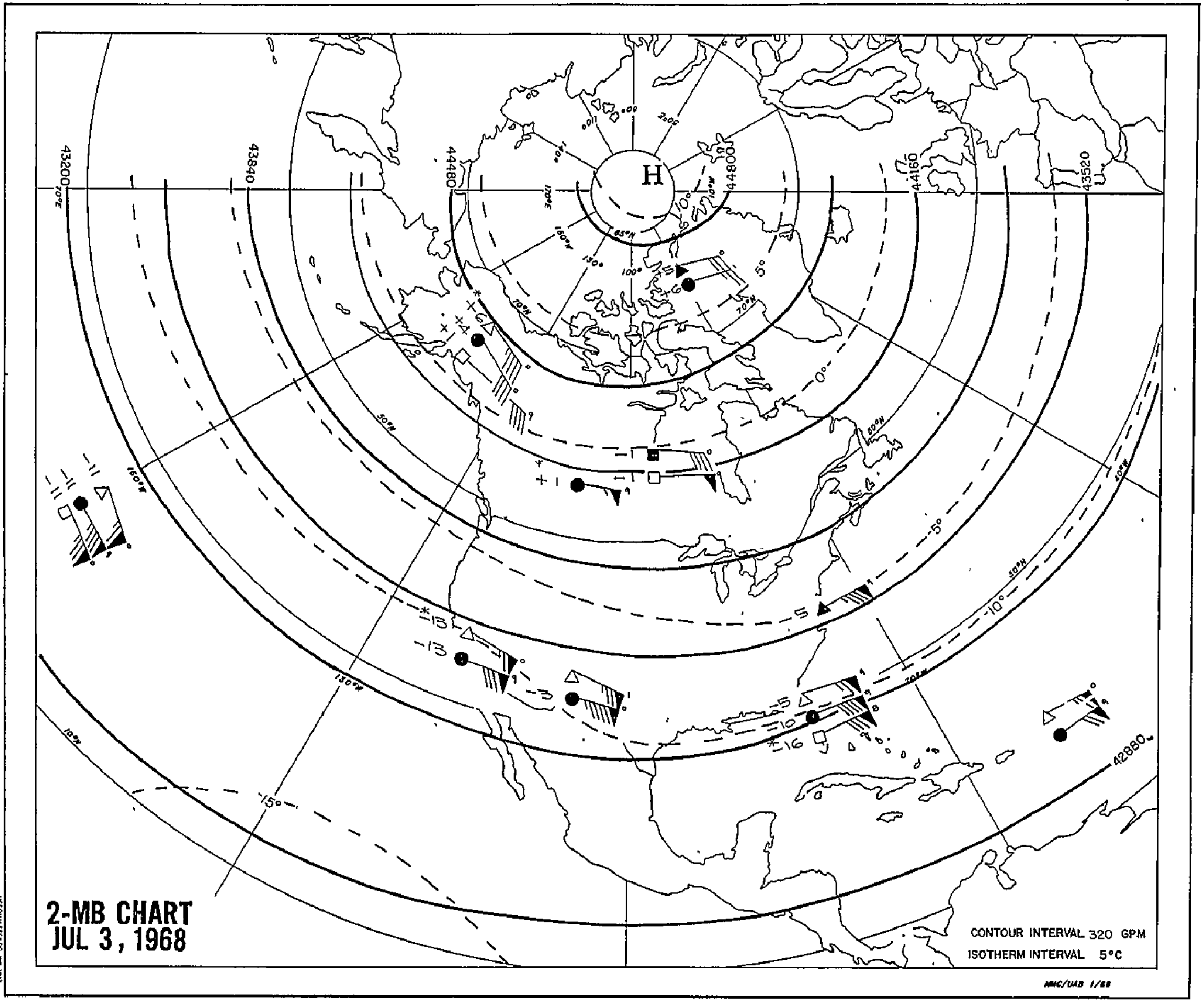
H
57760
57600
57280
56960
56640
56320
56000
55680
55360
0.4-MB CHART
JUN19, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C

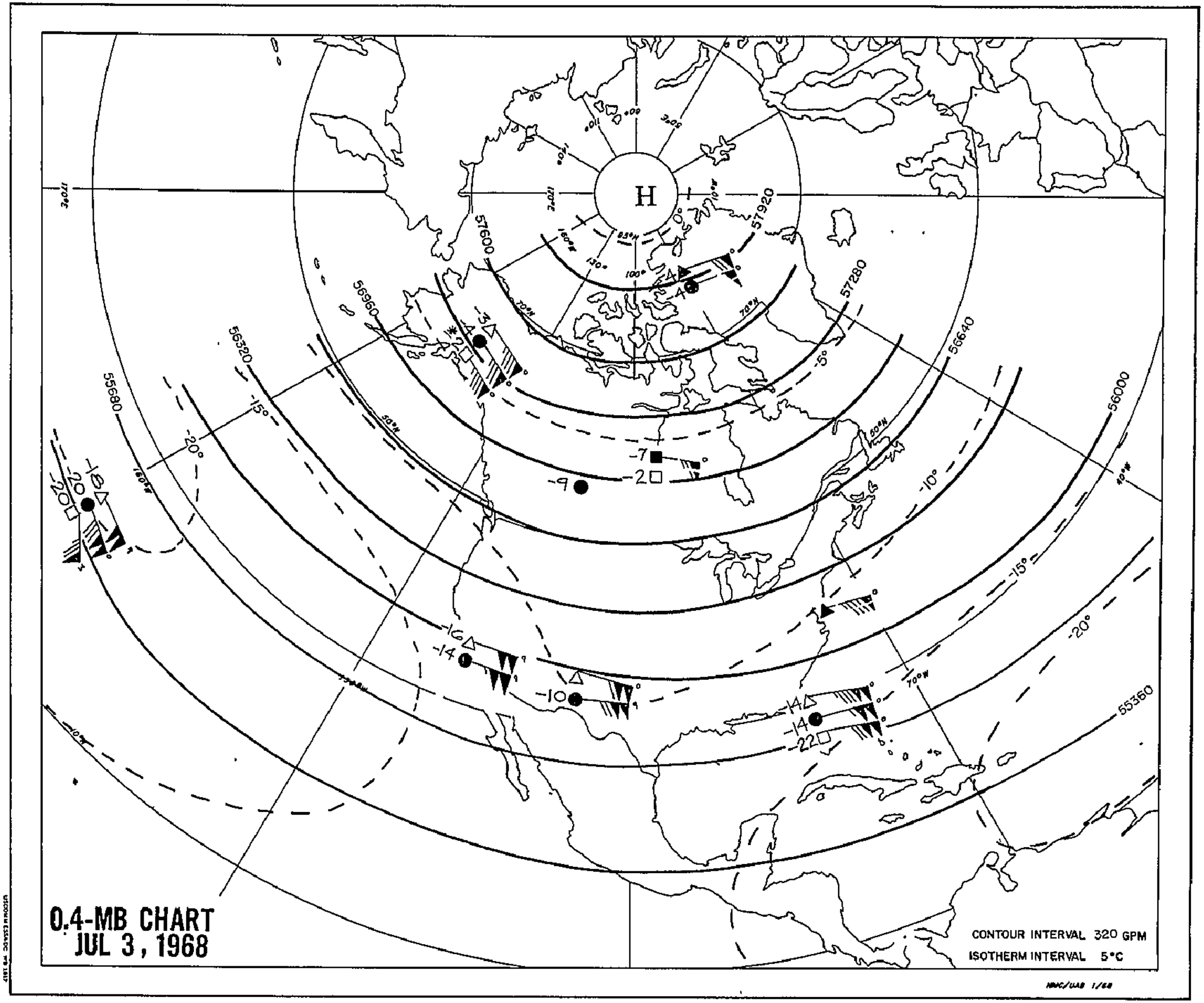

5-MB CHART
JUN 26,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
36800
37120
36480
37280
36160
36000
-10°
-15°
-20°
-25°
-30°


2-MB CHART
JUN 26,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
NMC/UAB 1/68
43200
43840
44480
44800
44160
43520
42880
0°
-5°
-10°
5°
10°

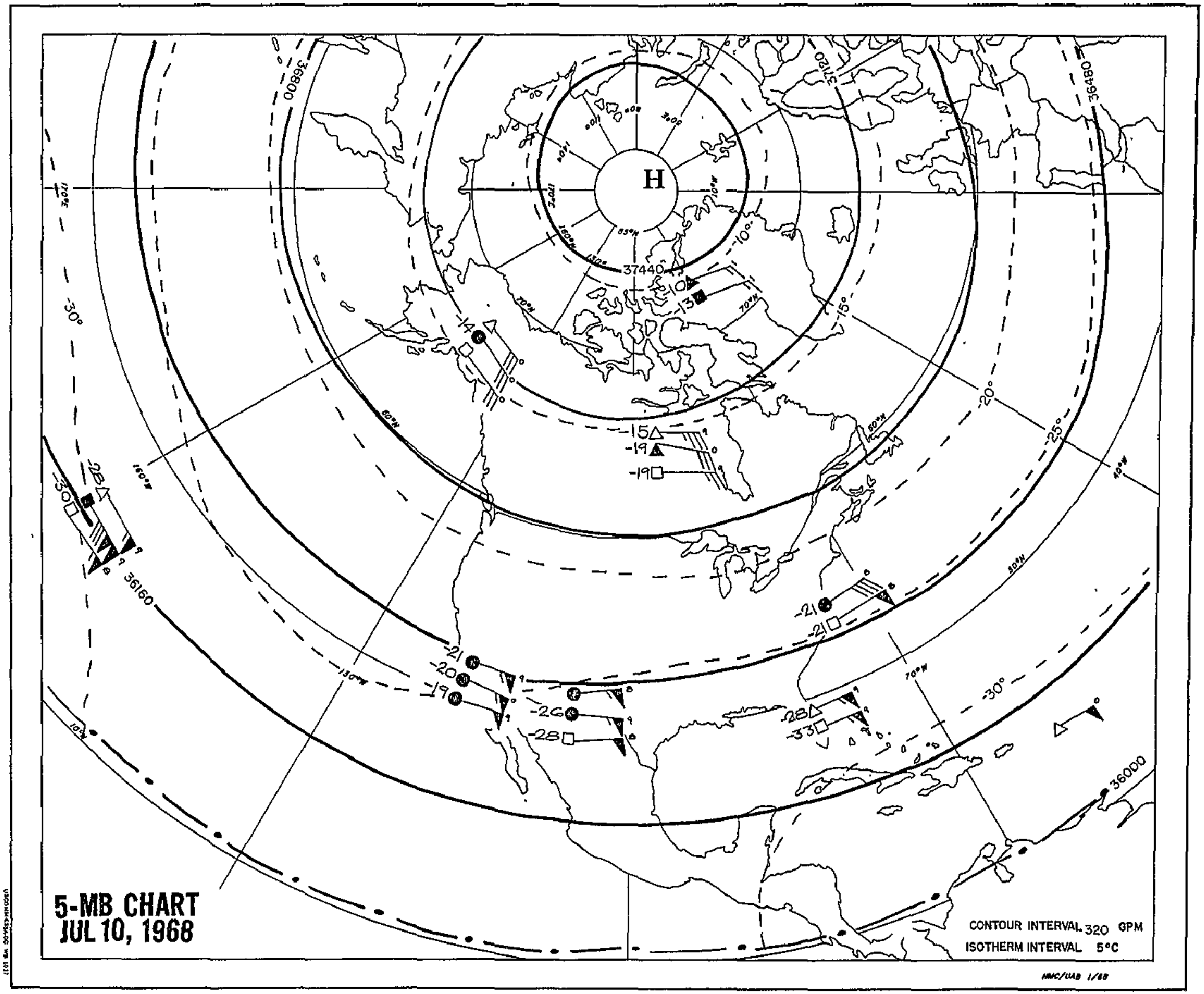

0.4-MB CHART
JUN 26,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
57920
57600
57280
56960
56640
56320
56000
55680
55360
-5°
-10°
-15°
0°


5-MB CHART
JUL 3, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
37440
36800
36480
36160
36000
-15°
-10°
-25°
-30°
H

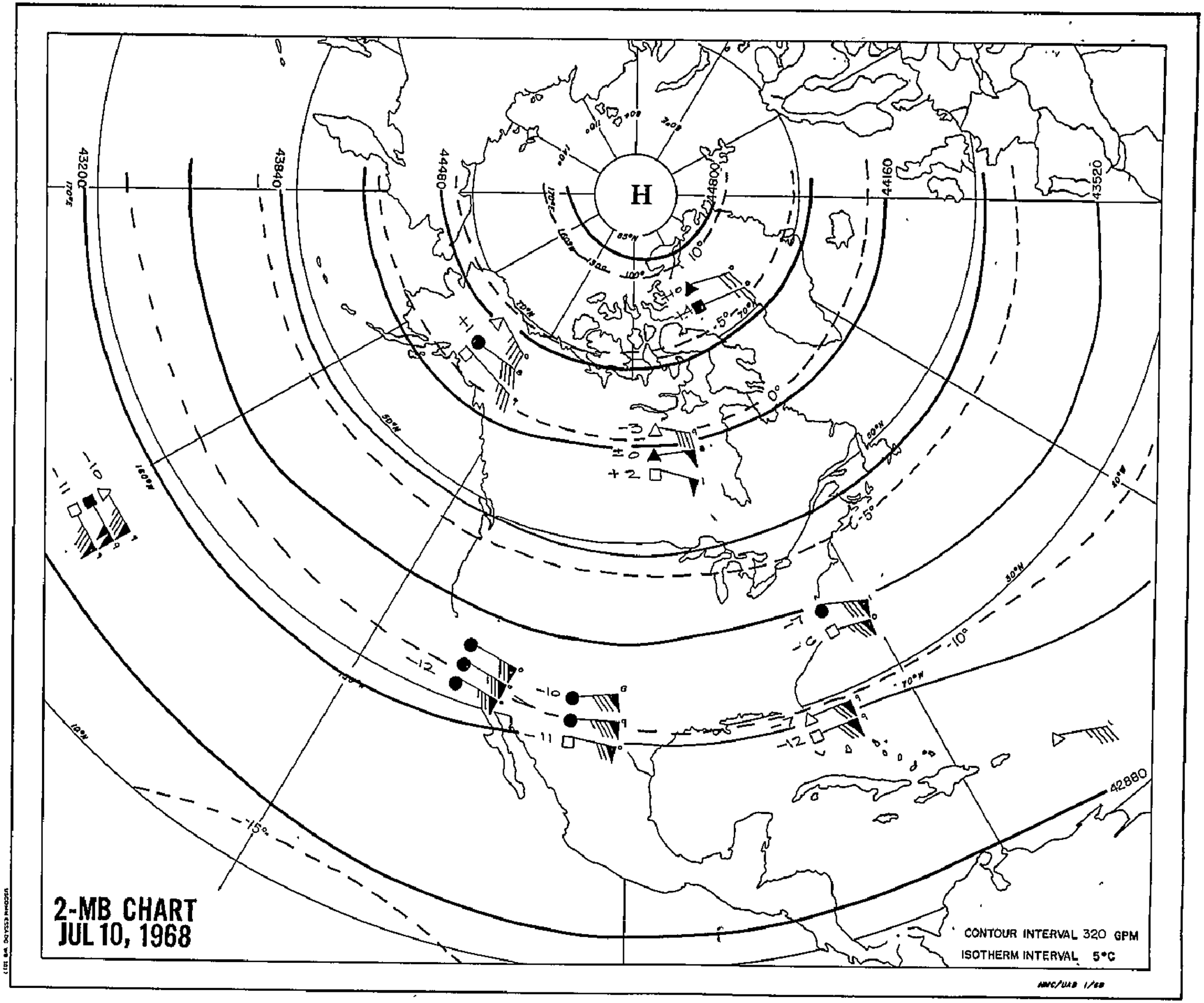

2-MB CHART
JUL 3, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
43200
43840
44480
44800
44160
43520
42880
H
0°
-5°
-10°
-15°
5°
10°

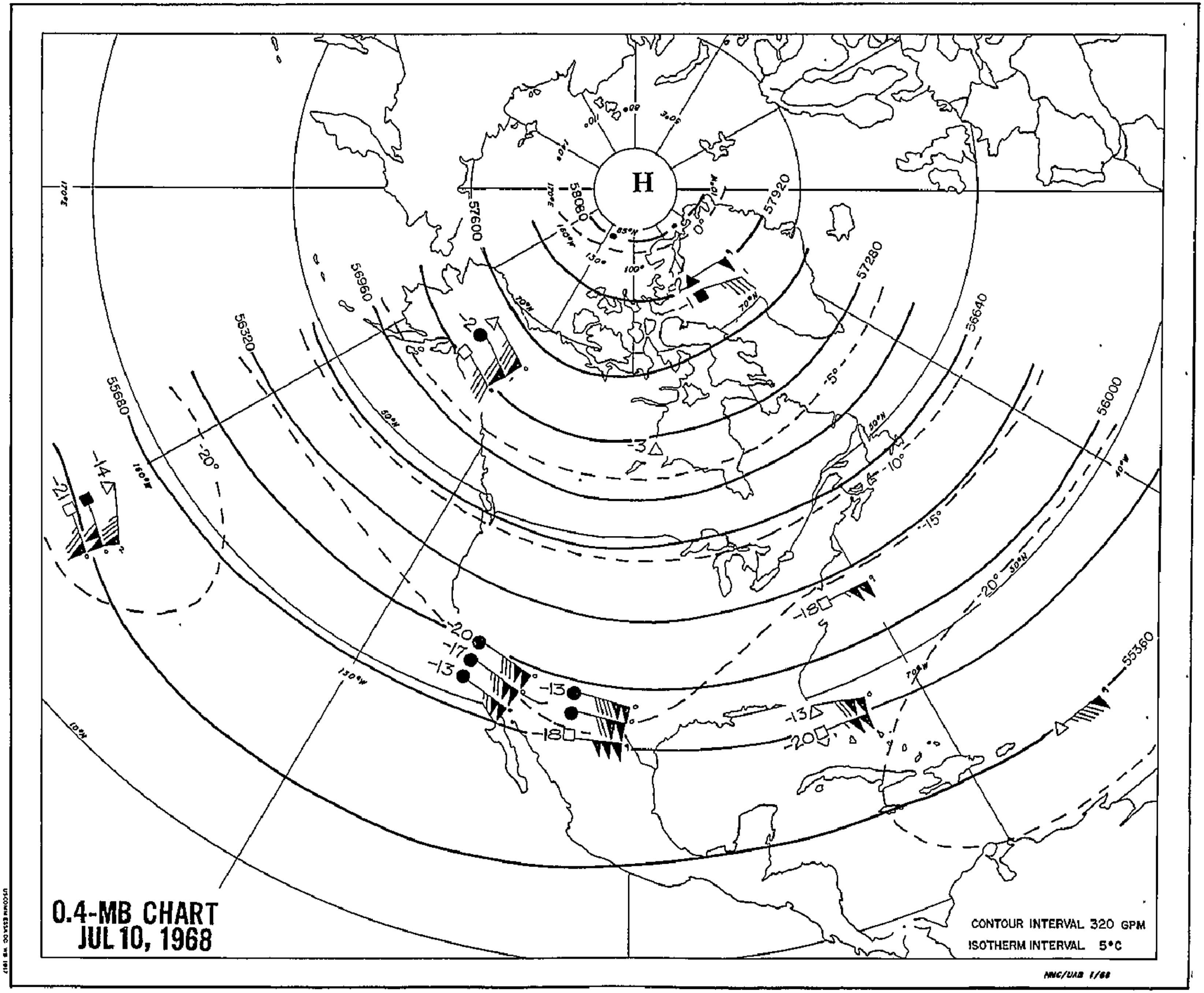


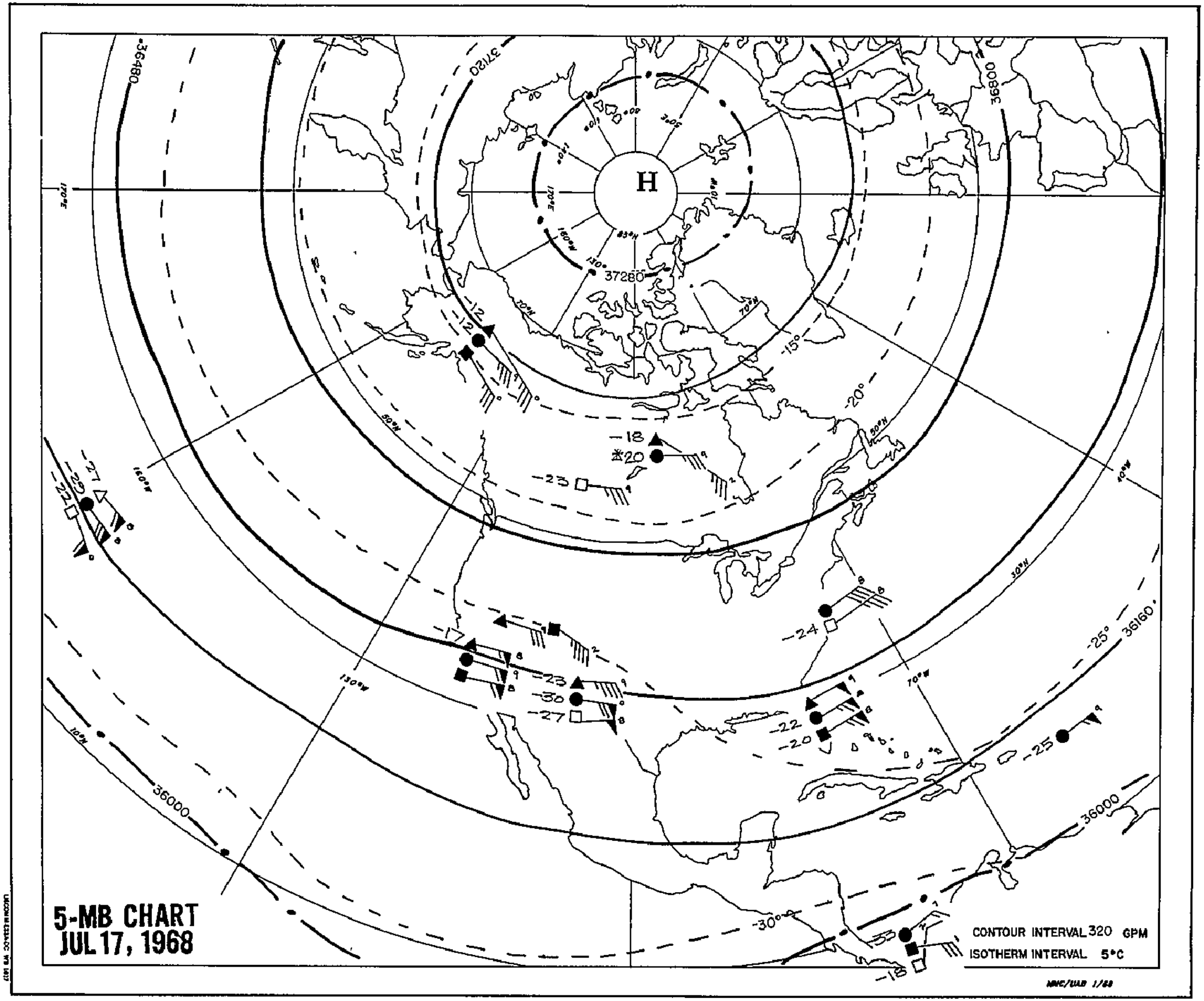
0.4-MB CHART
JUL 3, 1968

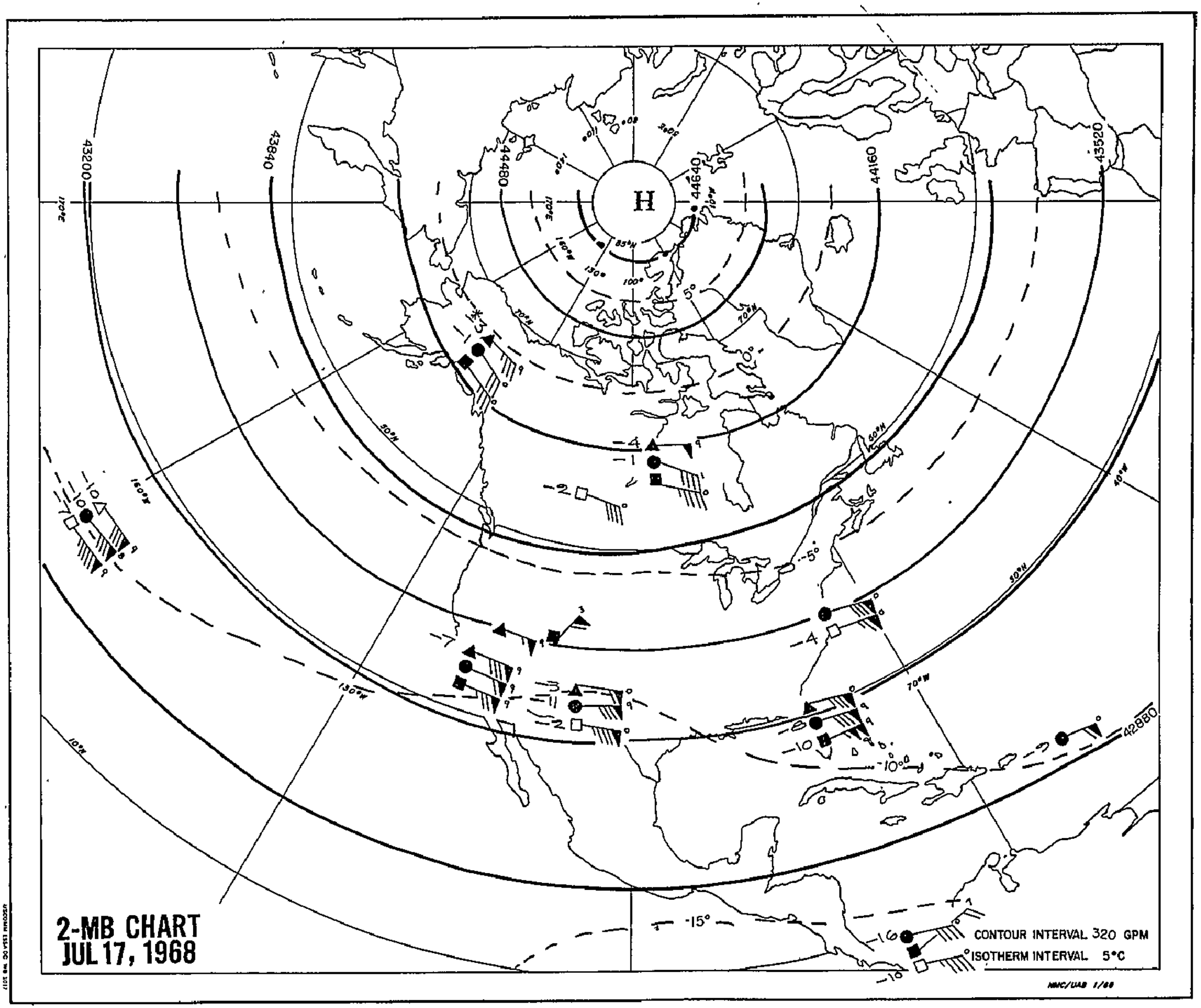


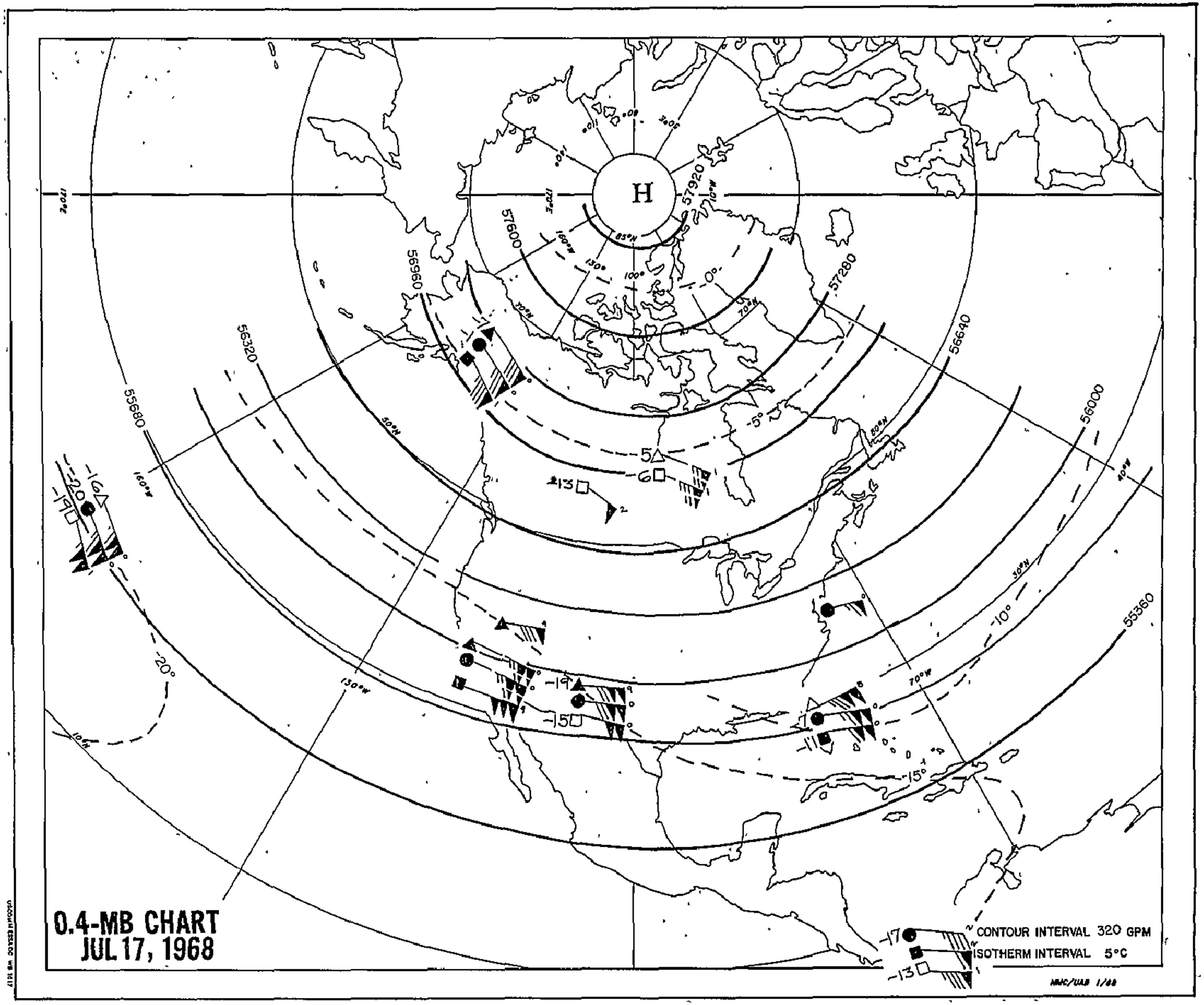
5-MB CHART
JUL 10, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
37440
37120
36800
36480
36160
36000
-10°
-15°
-20°
-25°
-30°

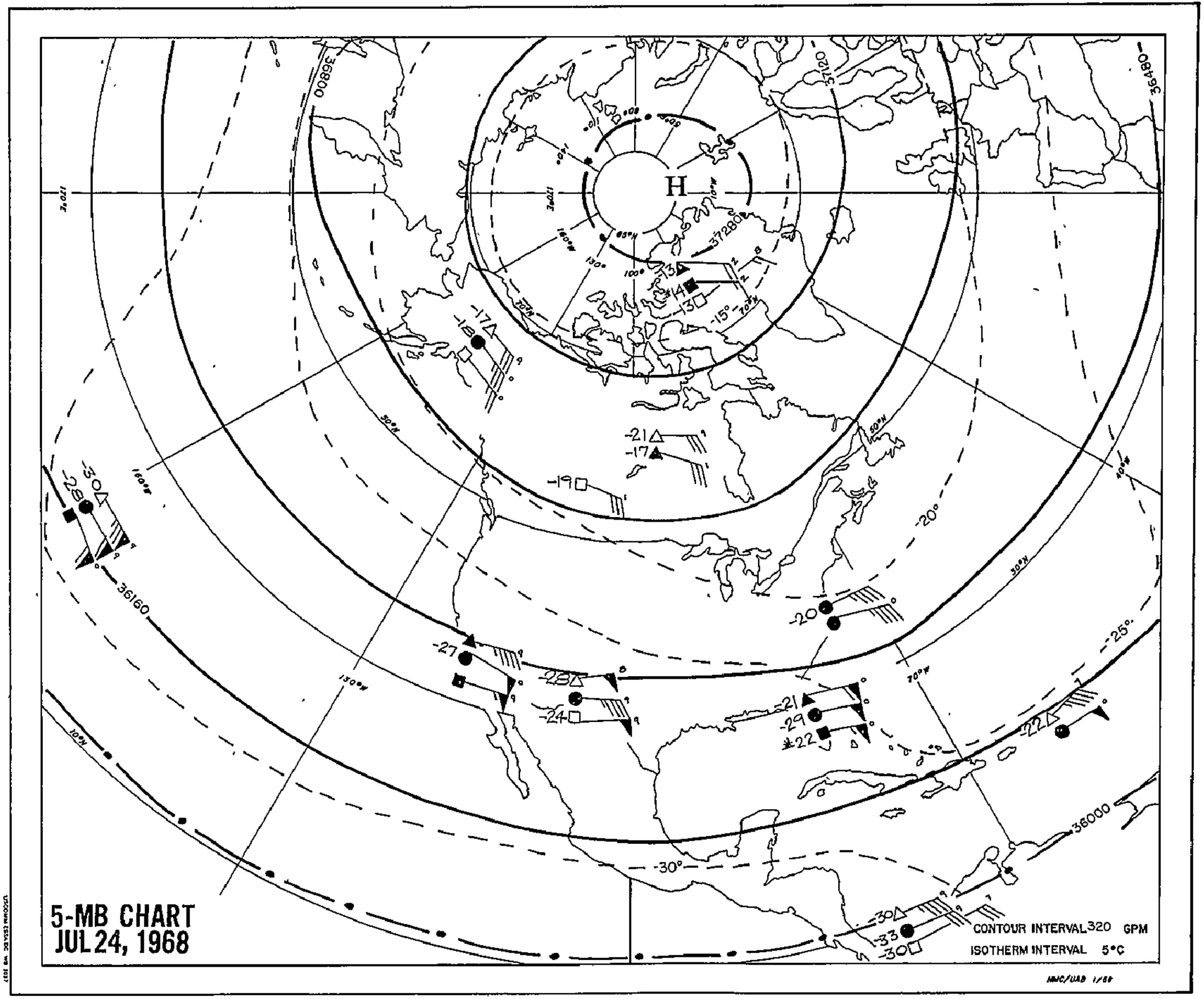

2-MB CHART
JUL 10, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
43200
43840
44480
44800
44160
43520
42880
10°
5°
0°
-5°
-10°
-15°

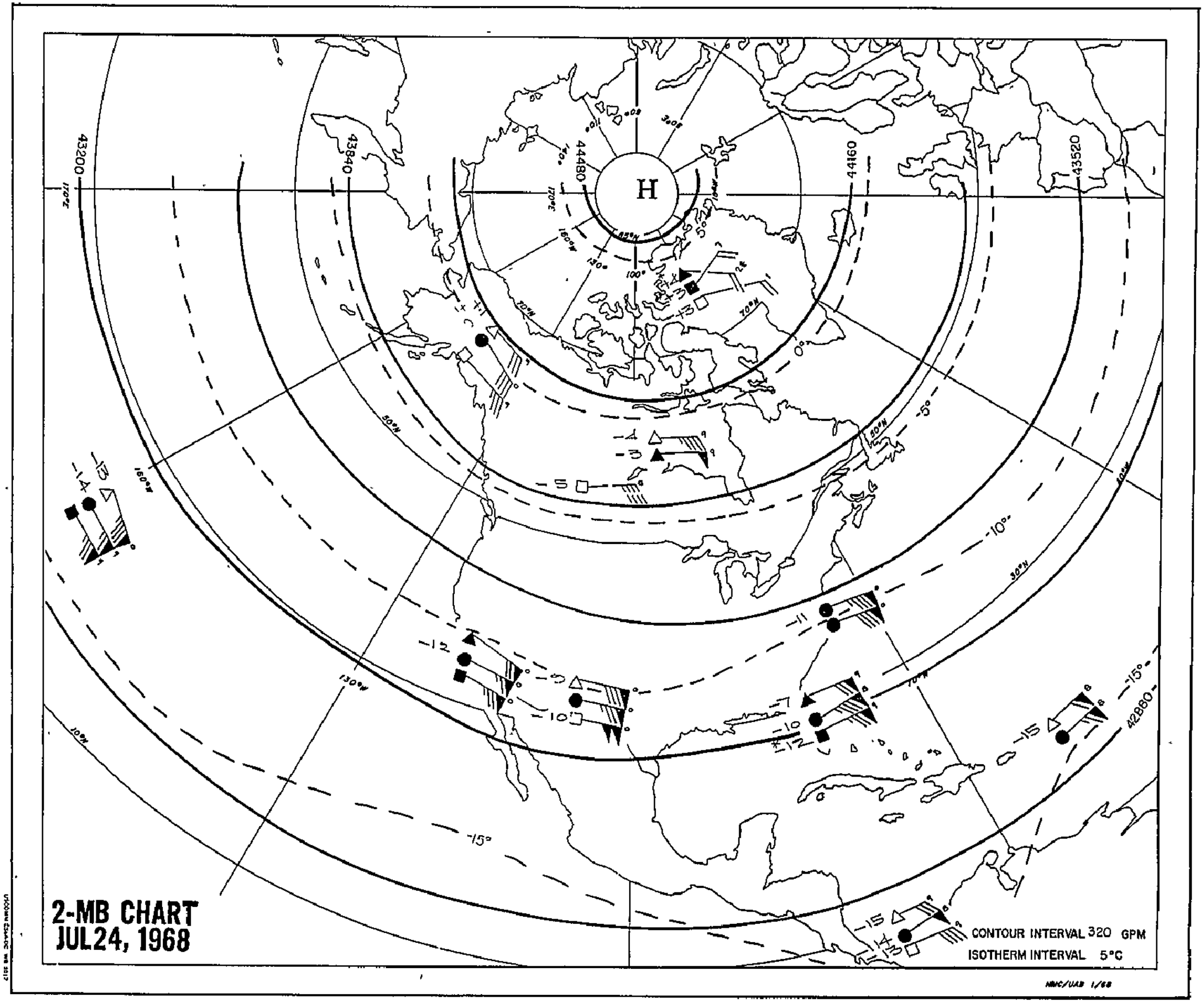

0.4-MB CHART
JUL 10, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
58080
57920
57600
57280
56960
56640
56320
56000
55680
55360
-5°
-10°
-15°
-20°
NMC/UAB 1/68

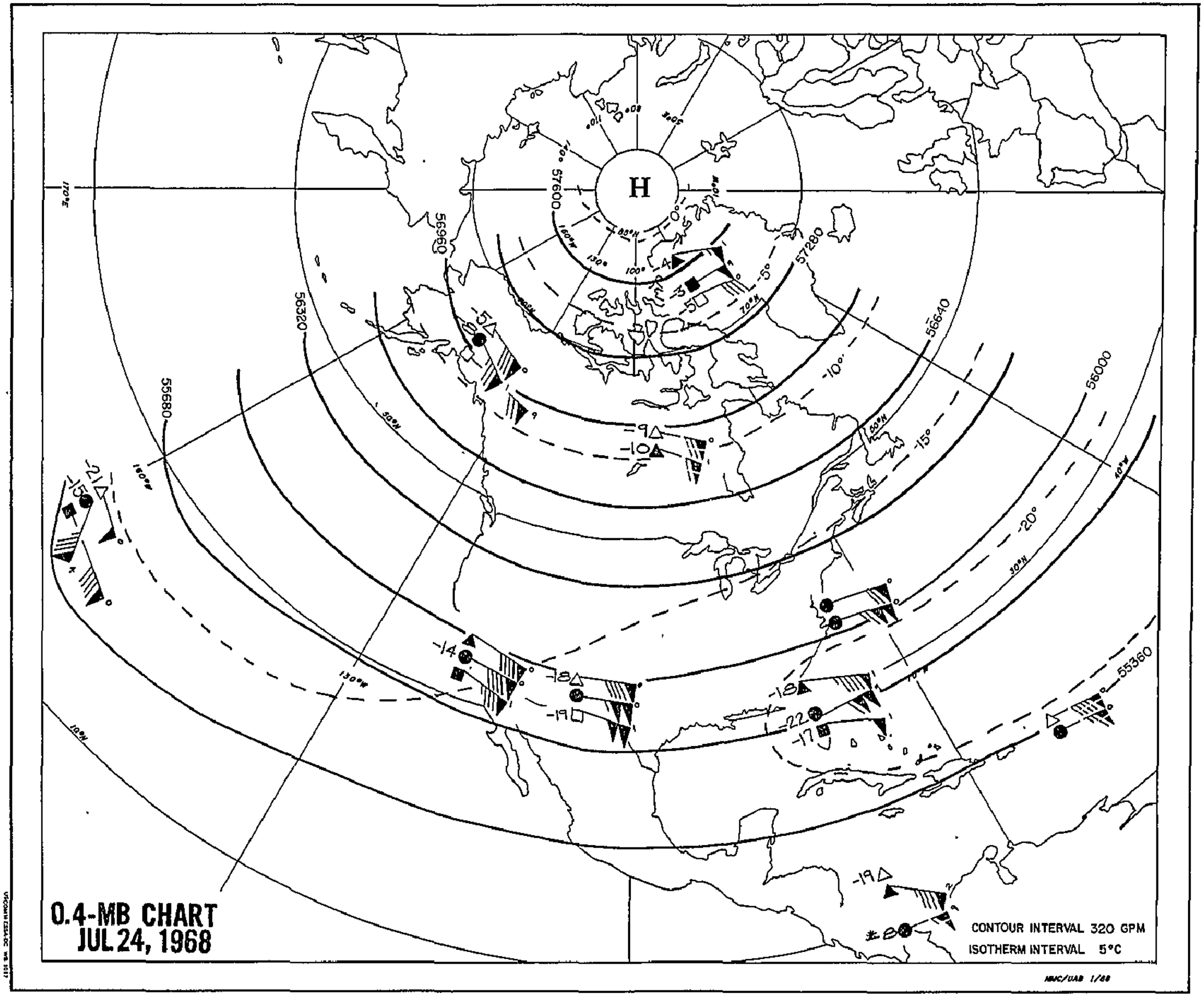

5-MB CHART
JUL 17, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
37280
37120
36800
36480
36160
36000
36000
-15°
-20°
-25°
-30°


2-MB CHART
JUL 17, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
43200
43840
44480
44640
44160
43520
42880

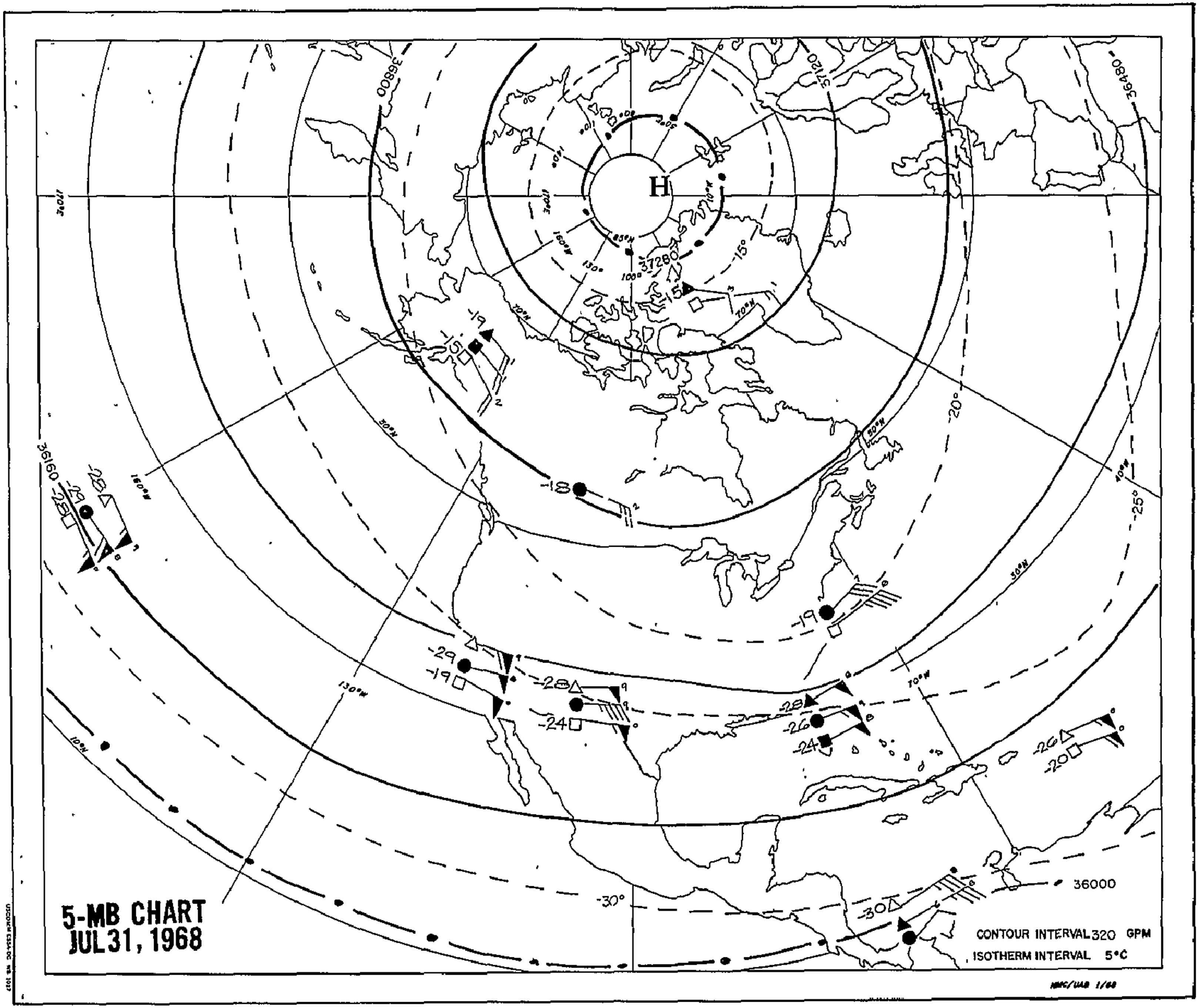

H
57920
57600
57280
56960
56640
56320
56000
55680
55360
0°
-5°
-10°
-15°
-20°
0.4-MB CHART
JUL 17, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C

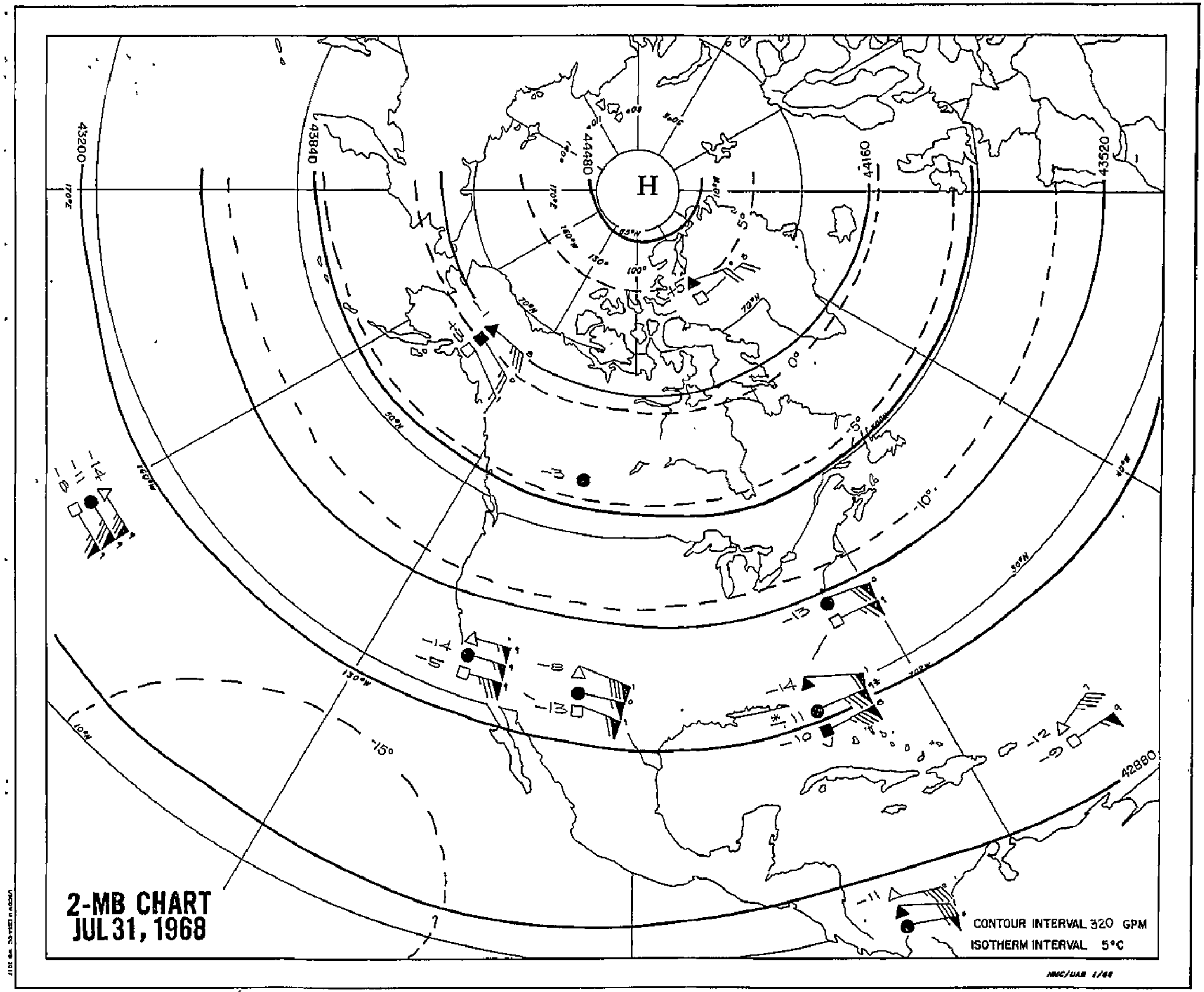

5-MB CHART
JUL 24, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
36800
37120
36480
37280
36160
36000
-15°
-20°
-25°
-30°
NMC/UAD 1/66

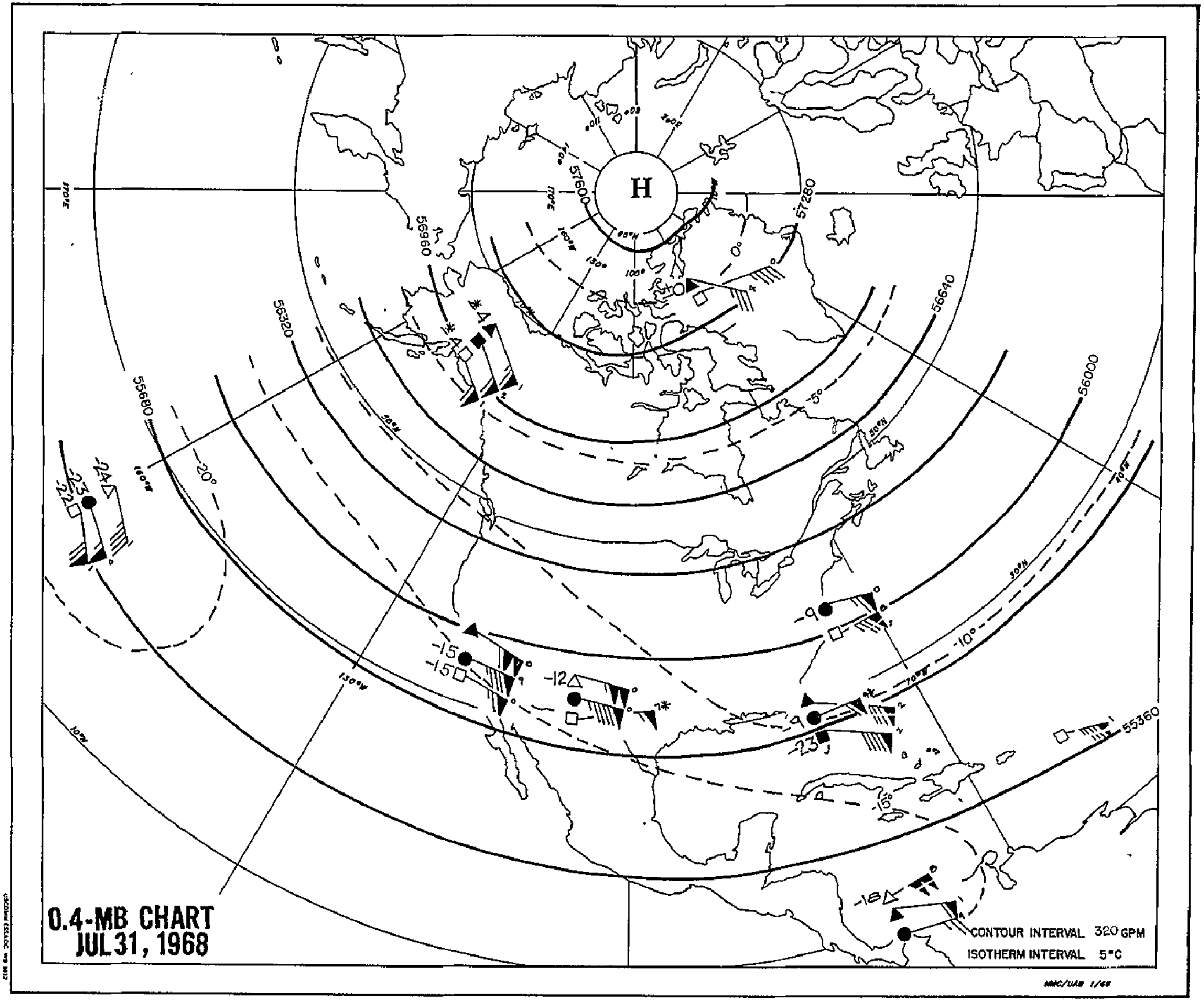

H
43200
43840
44480
44160
43520
42880
0°
-5°
-10°
-15°
-15°
2-MB CHART
JUL24, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
NMC/UAB 1/68



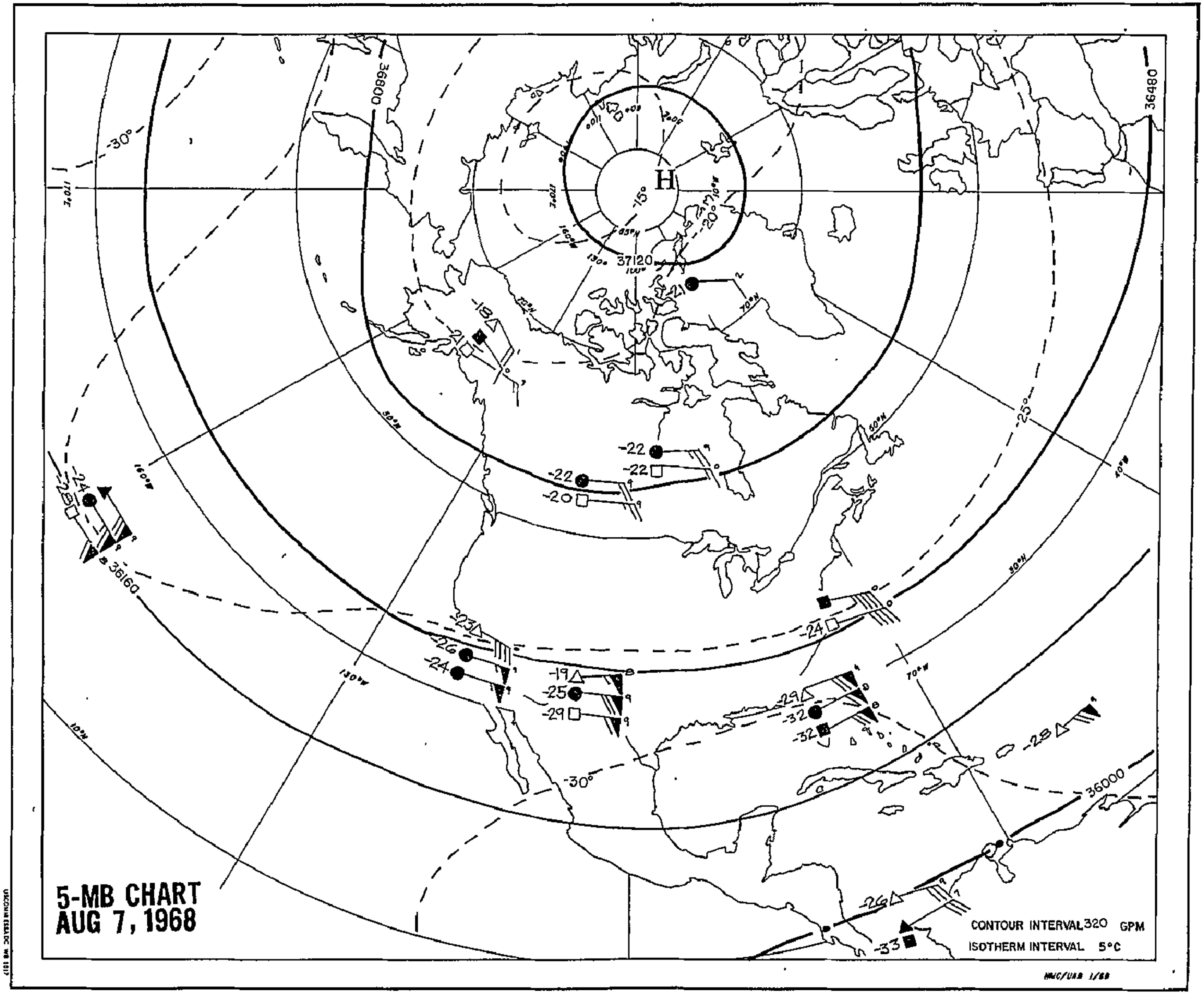
0.4-MB CHART
JUL 24, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
57600
57280
56960
56640
56320
56000
55680
55360
0°
-5°
-10°
-15°
-20°

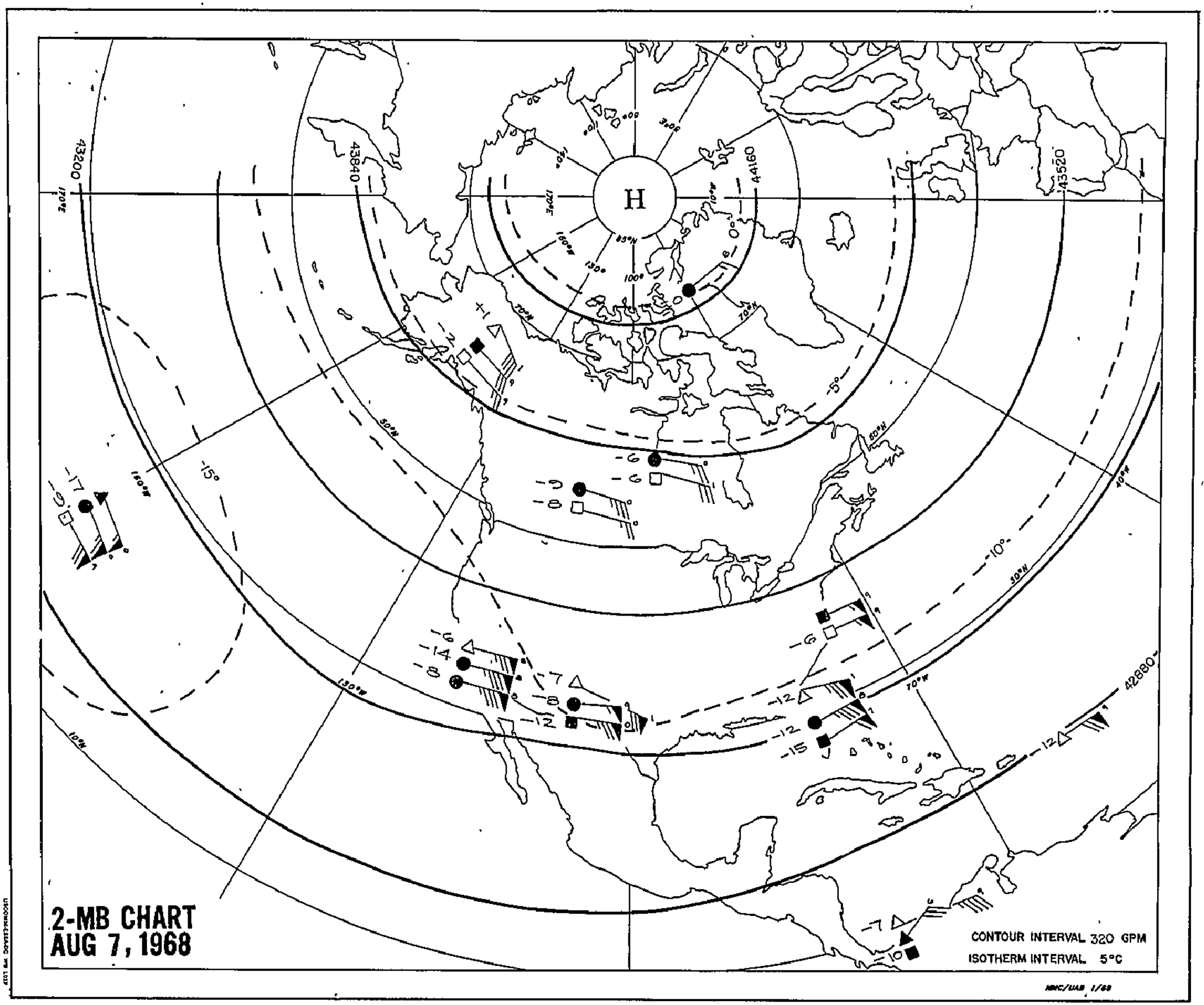

5-MB CHART
JUL 31, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
37280
37120
36800
36480
36160
36000
-15°
-20°
-25°
-30°

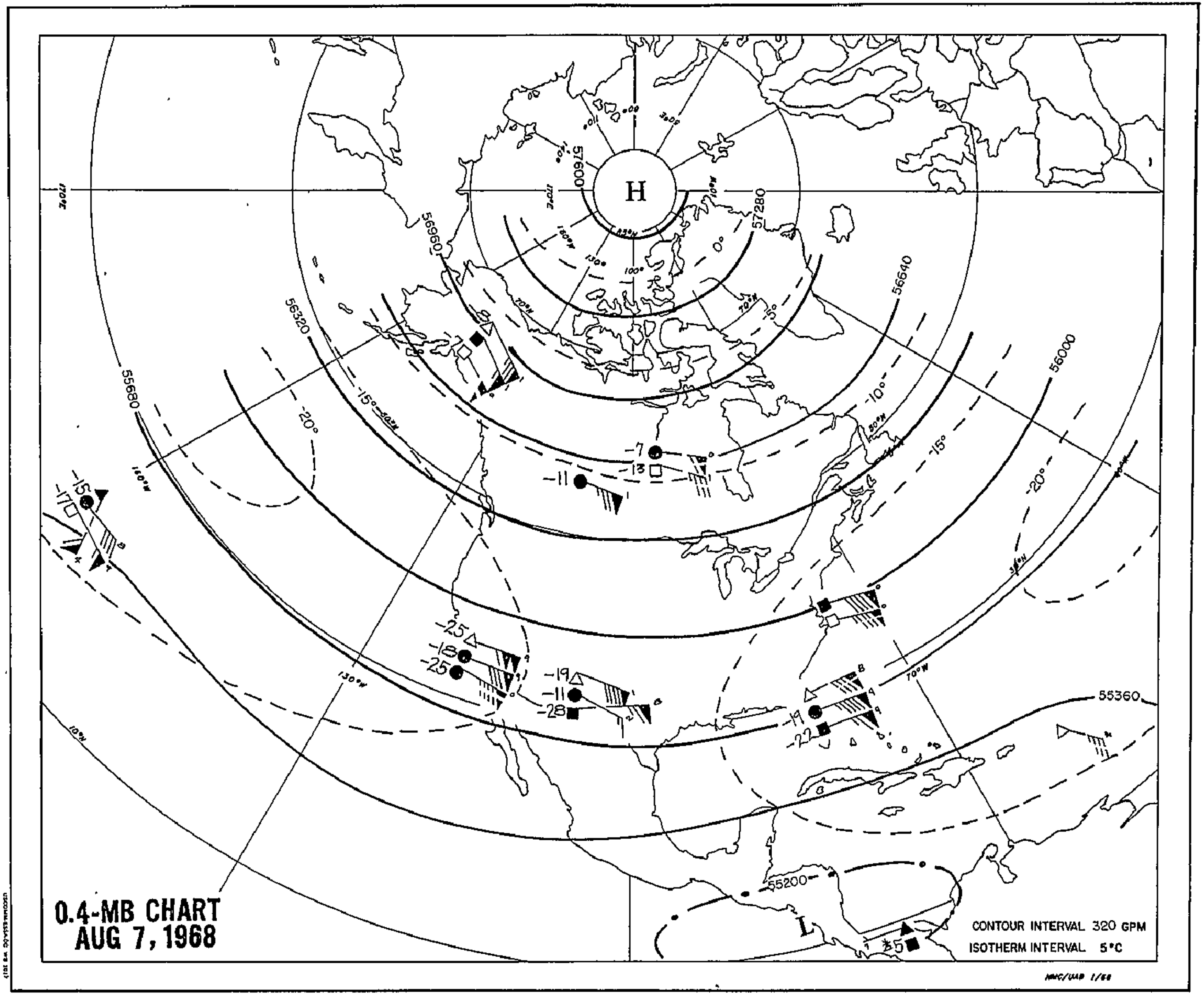

2-MB CHART
JUL 31, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
43200
43840
44480
44160
43520
42880
-15°
-10°
-5°
0°
5°

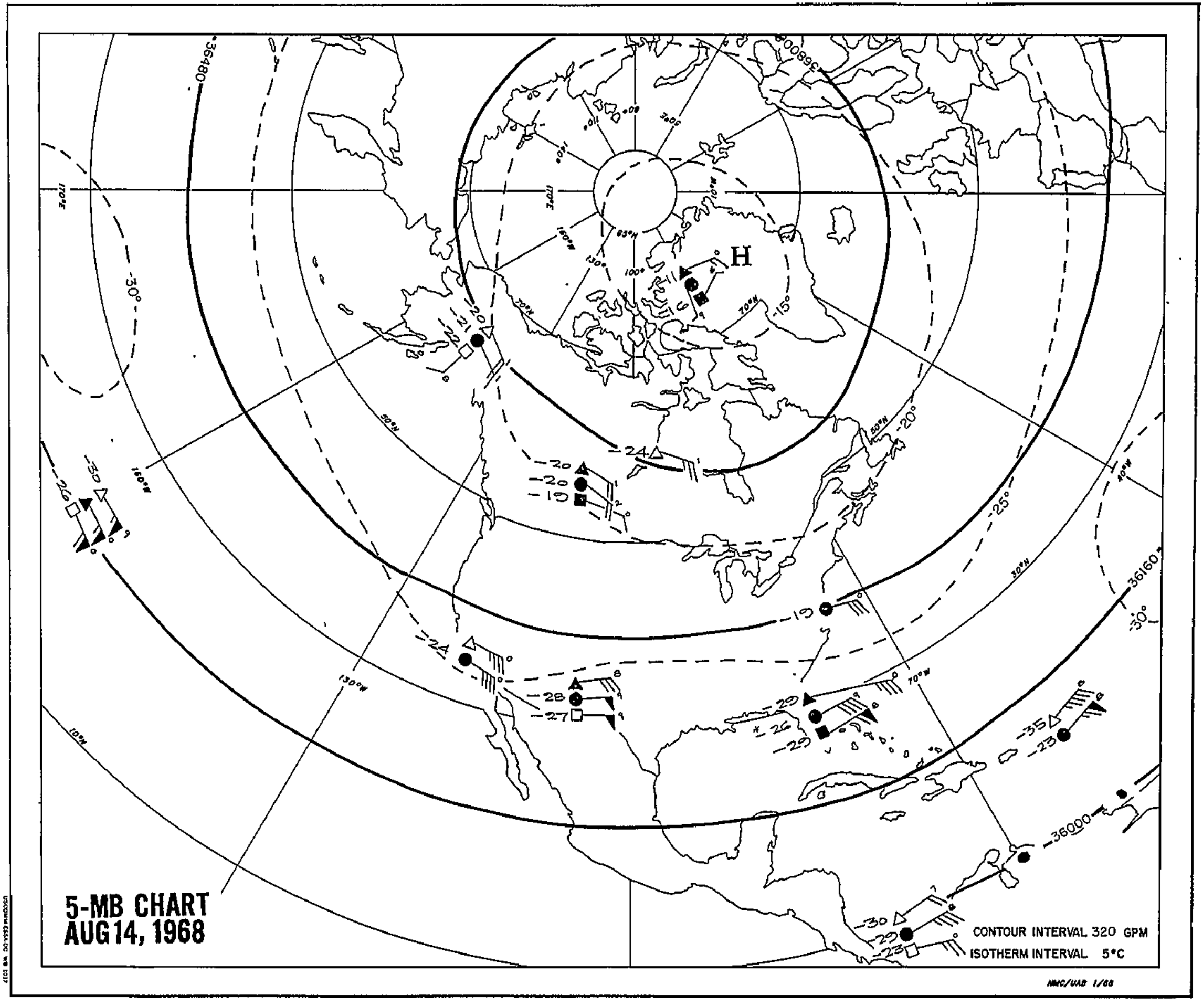

0.4-MB CHART
JUL 31, 1968
H
57600
57280
56960
56640
56320
56000
55680
55360
0°
-5°
-10°
-15°
-20°
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
NMC/UAB 1/69

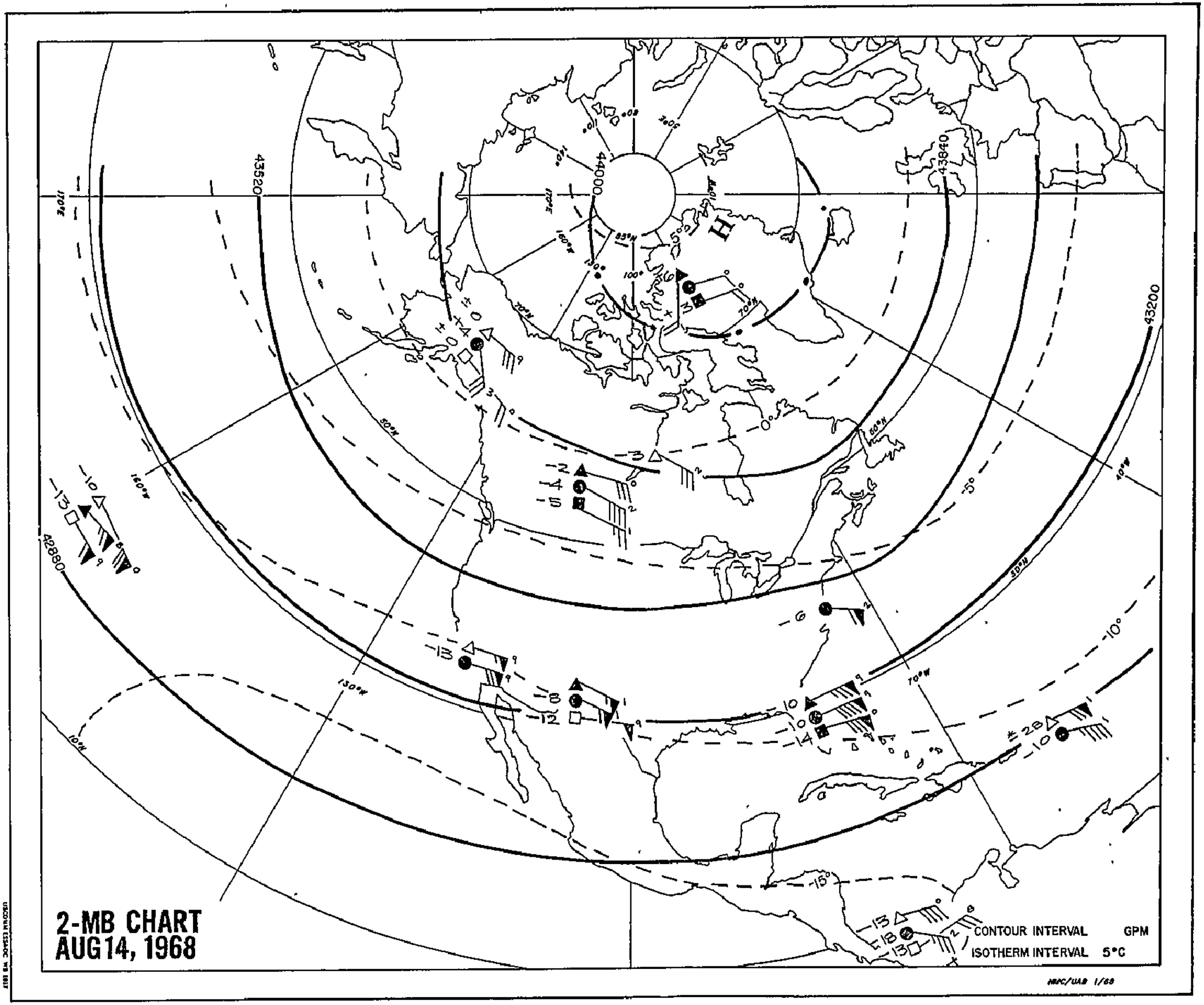
107

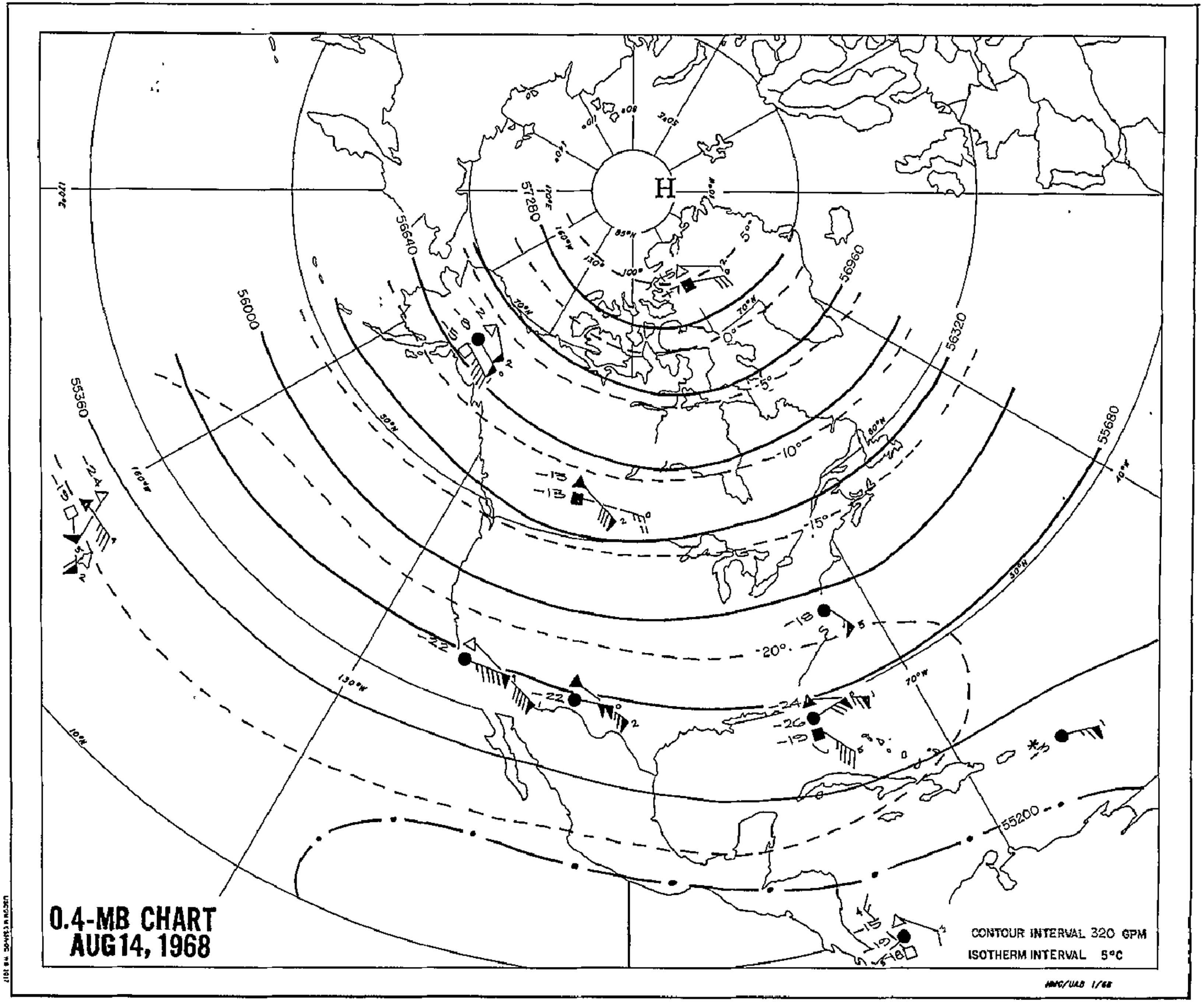

5-MB CHART
AUG 7, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
37120
36800
36480
36160
36000
-15°
-20°
-25°
-30°
NMC/UAB 1/68


2-MB CHART
AUG 7, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
43200
43840
44160
43520
42880
-5°
-10°
-15°
0°
NMC/UAB 1/68

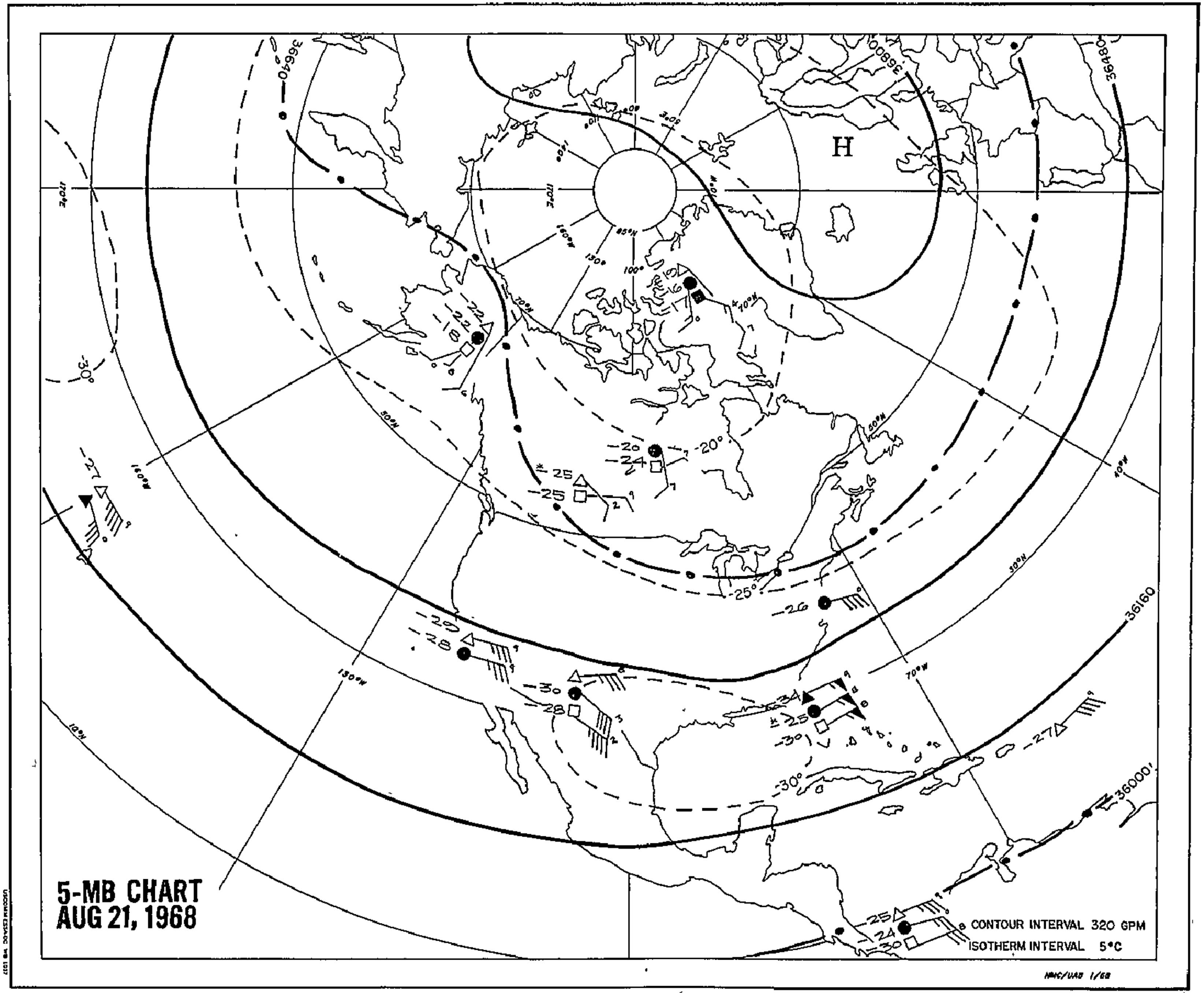

0.4-MB CHART
AUG 7, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
L
57600
57280
56960
56640
56320
56000
55680
55360
55200
0°
-10°
-15°
-20°
130°W
70°W
180°W

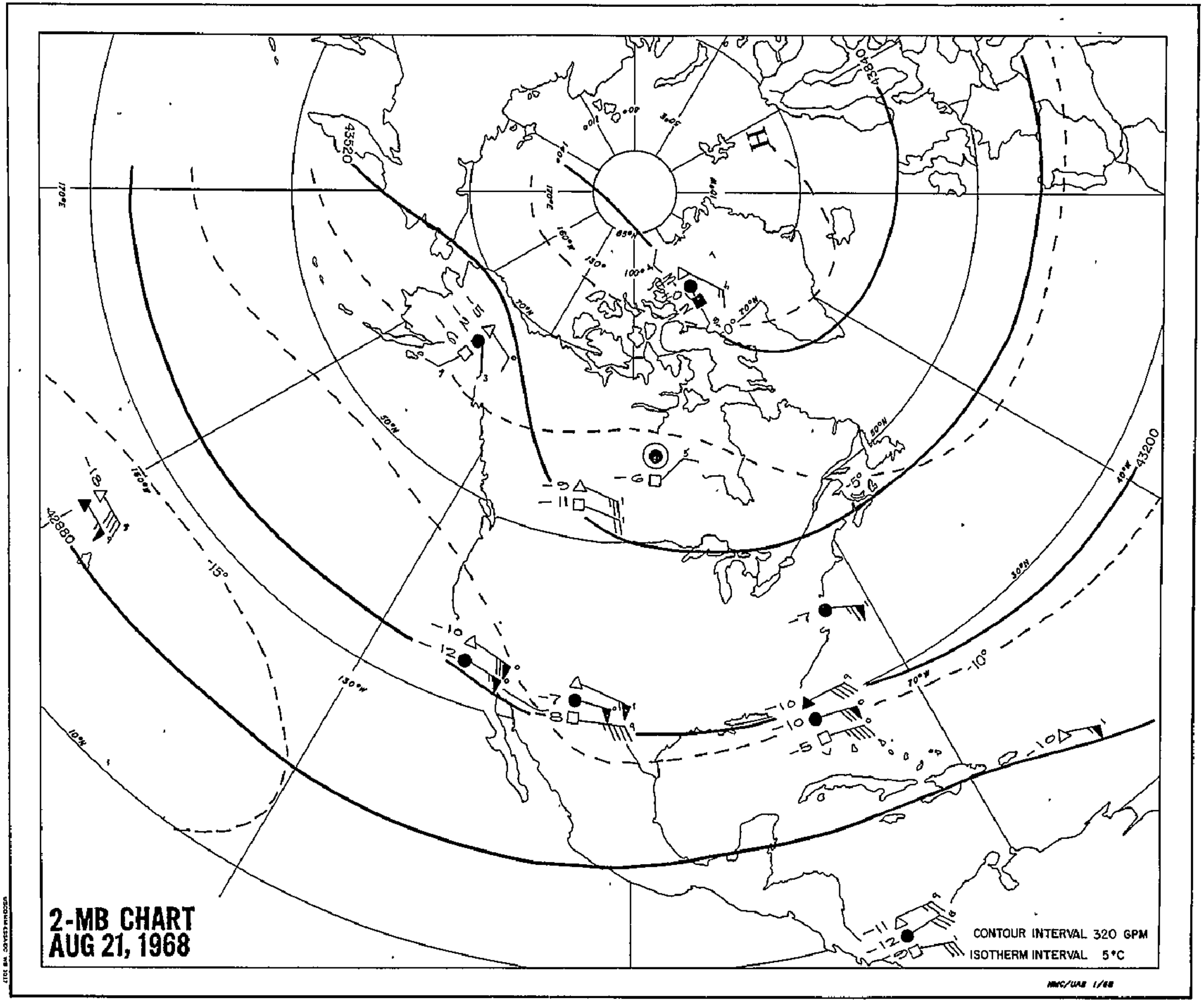

5-MB CHART
AUG 14, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
36800
36480
36160
36000
-15°
-20°
-25°
-30°
H

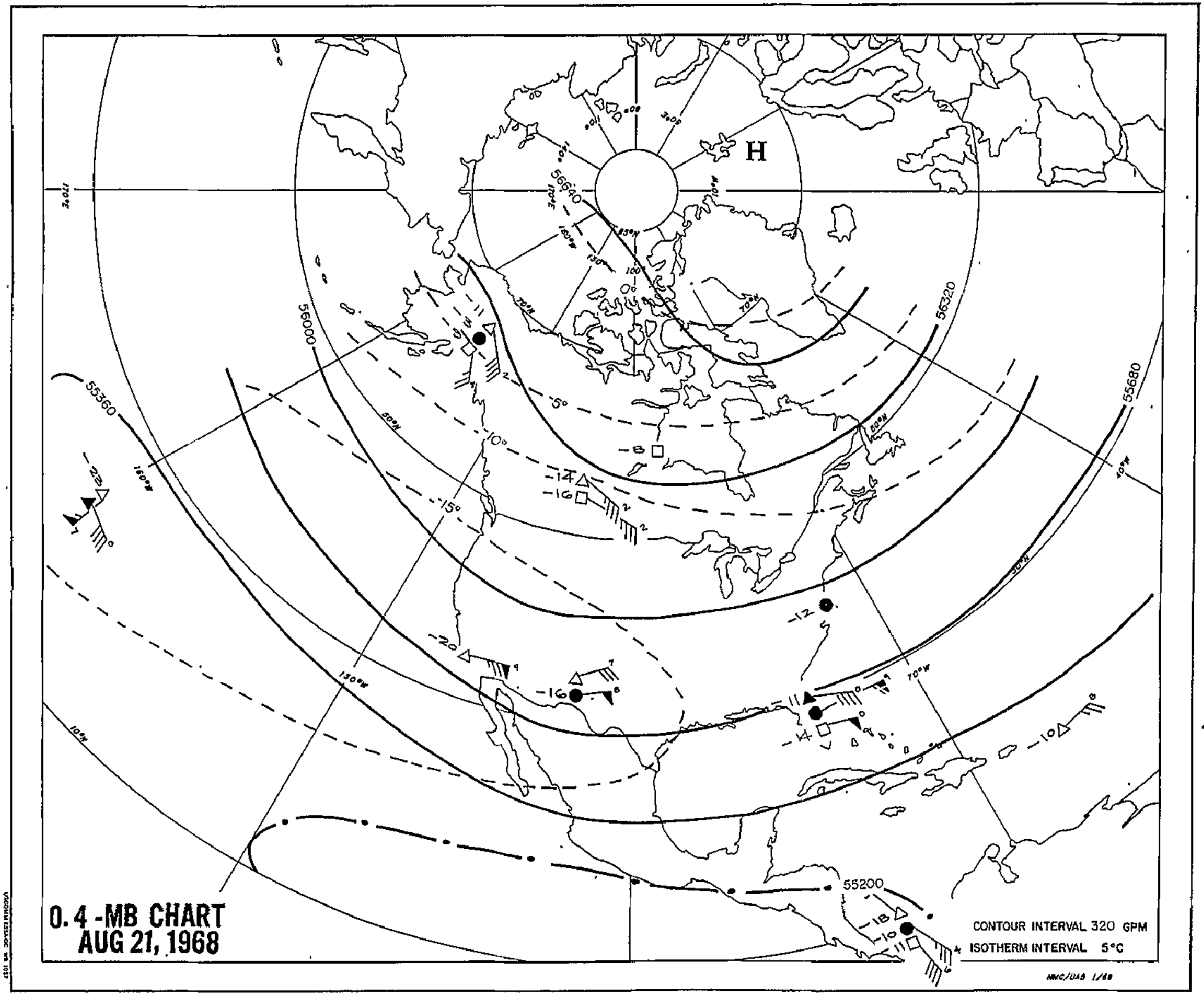

2-MB CHART
AUG14, 1968
CONTOUR INTERVAL GPM
ISOTHERM INTERVAL 5°C
43520
44000
43840
43200
42880
-5°
-10°
-15°
0°
5°

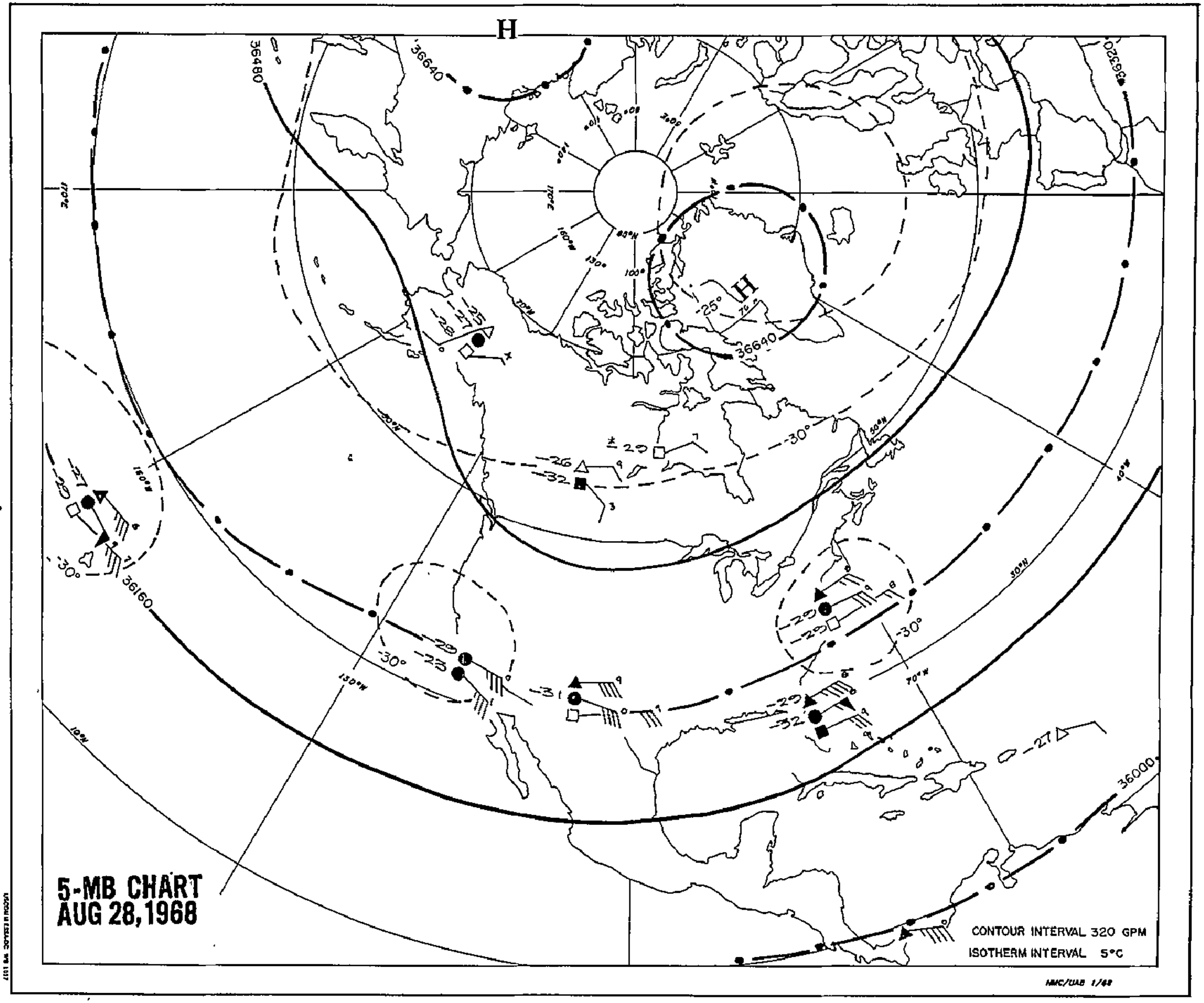


0.4-MB CHART
AUG 14, 1968

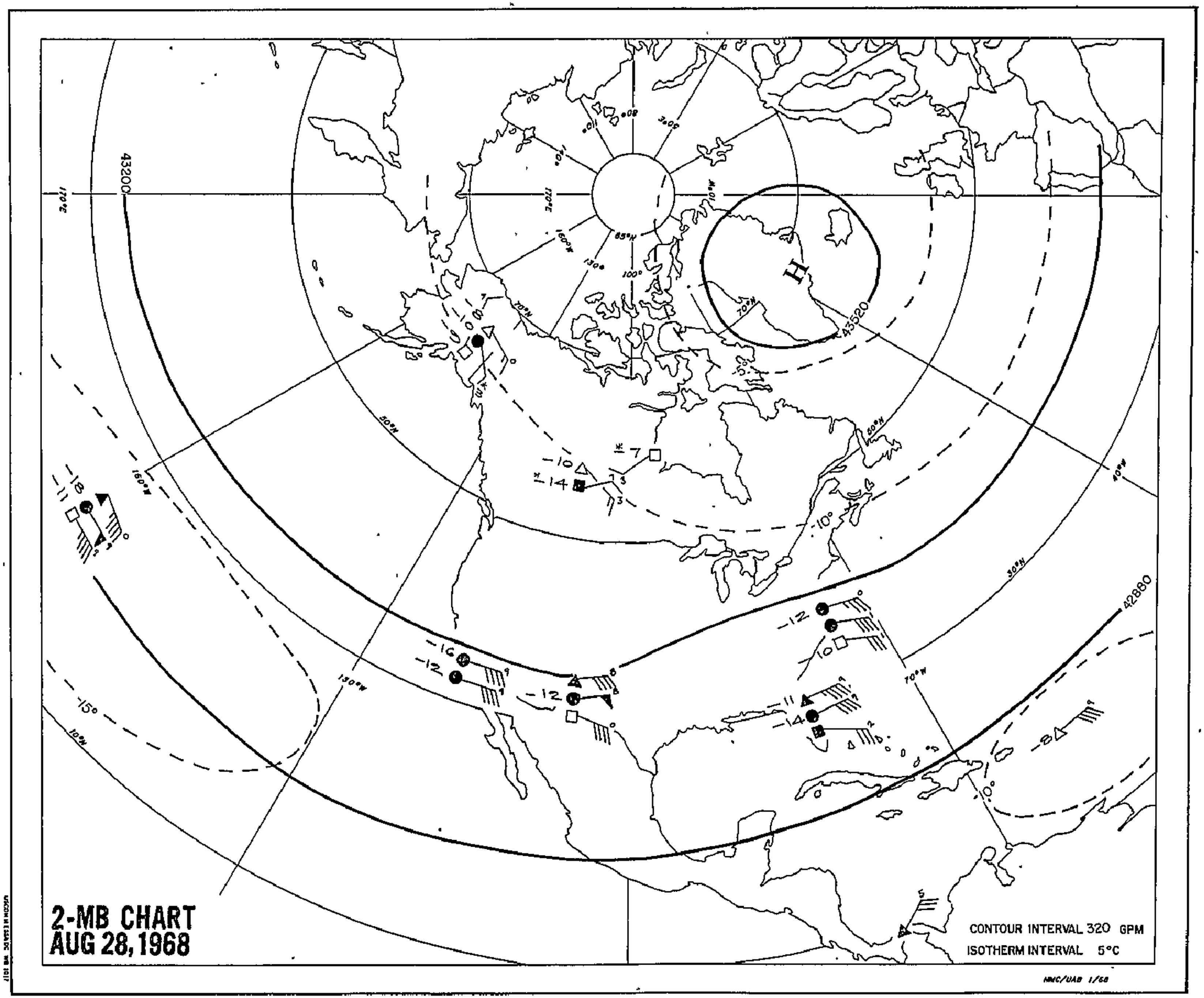

5-MB CHART
AUG 21, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
36640
36800
36480
36160
36000
H
-20°
-25°
-30°
NMC/UAB 1/68


2-MB CHART
AUG 21, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
43520
43200
42880
-15°
-10°
H
NMC/UAB 1/68

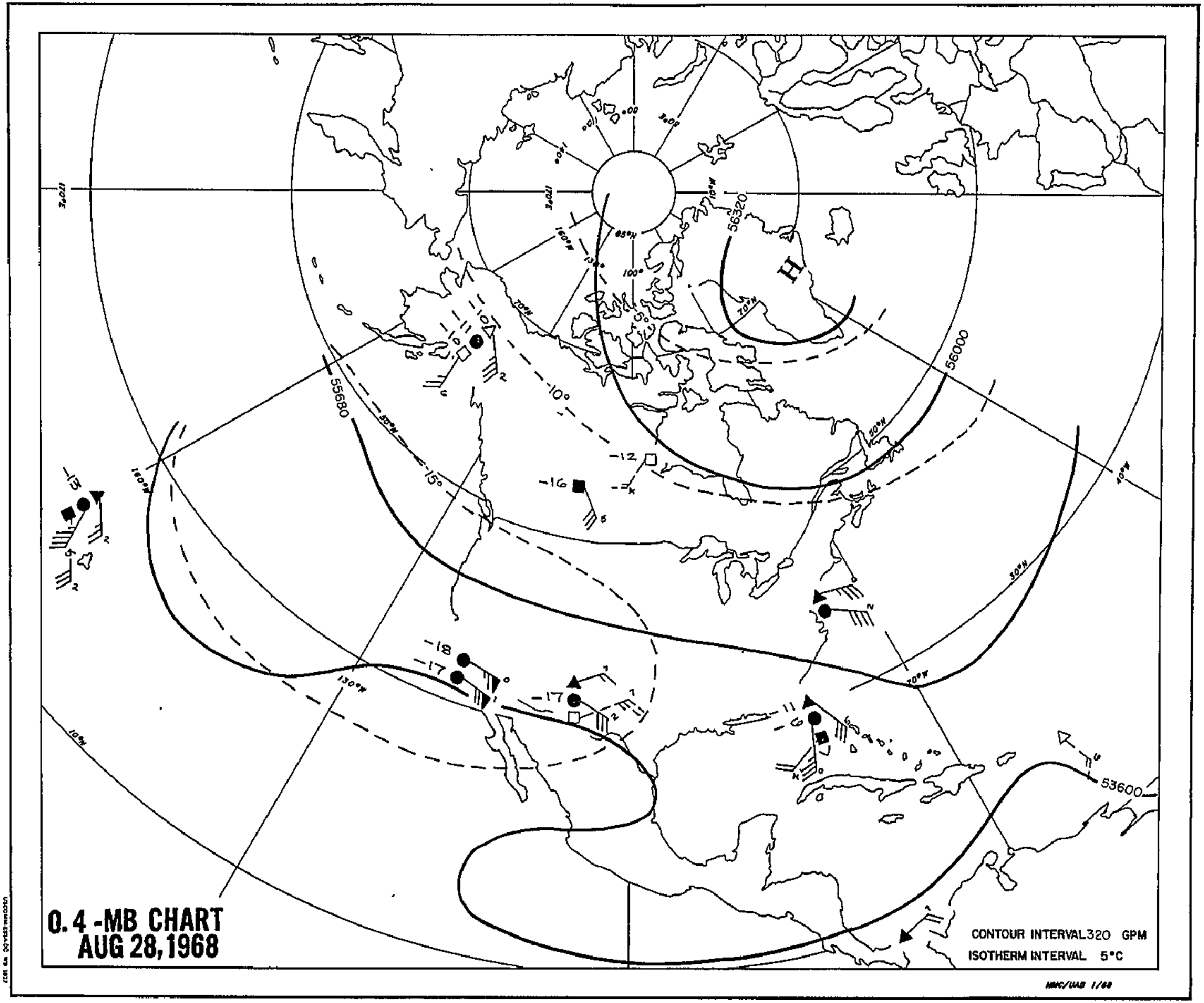

0.4 -MB CHART
AUG 21, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
56640
56320
56000
55680
55360
55200
-5°
-10°
-15°

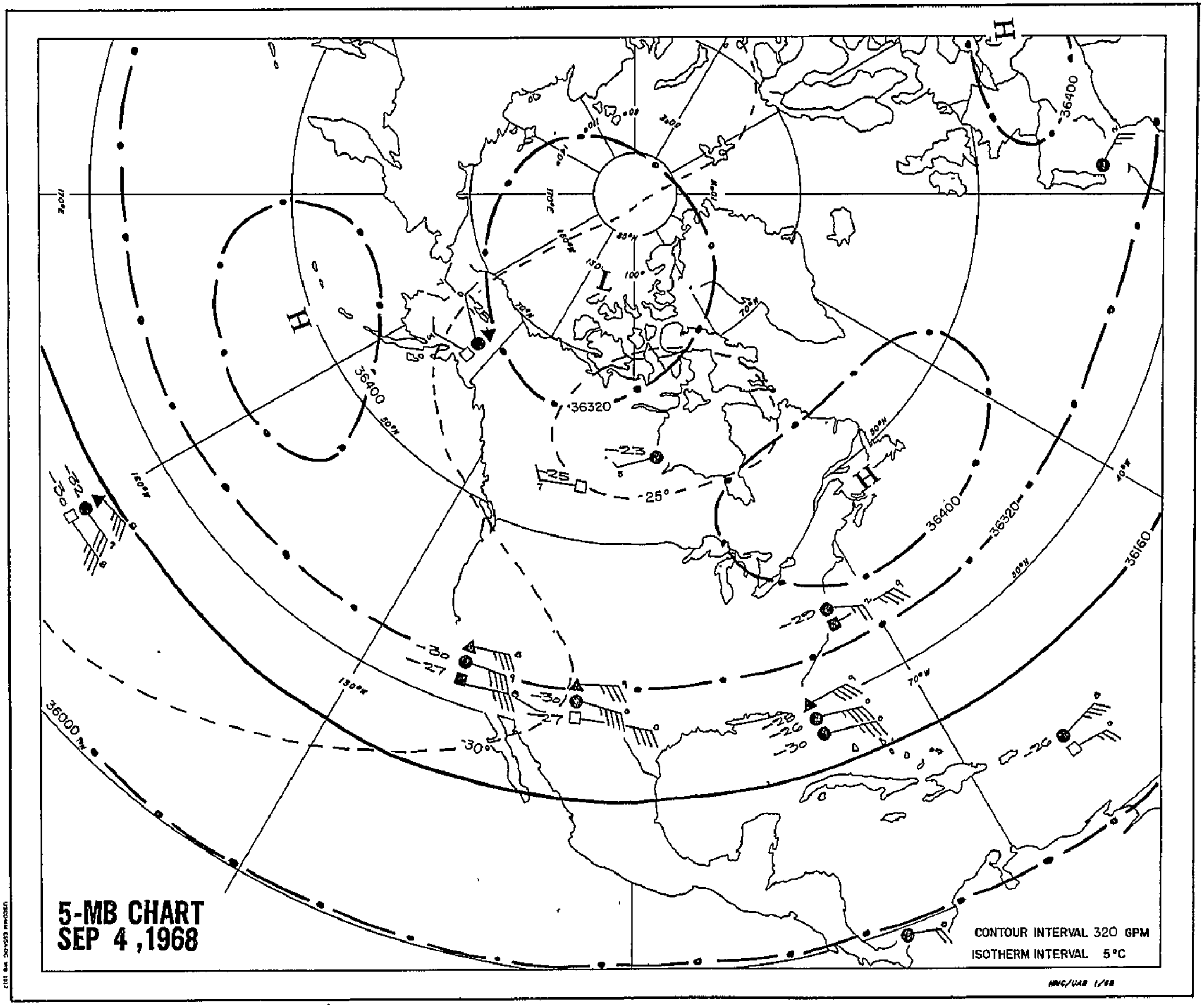


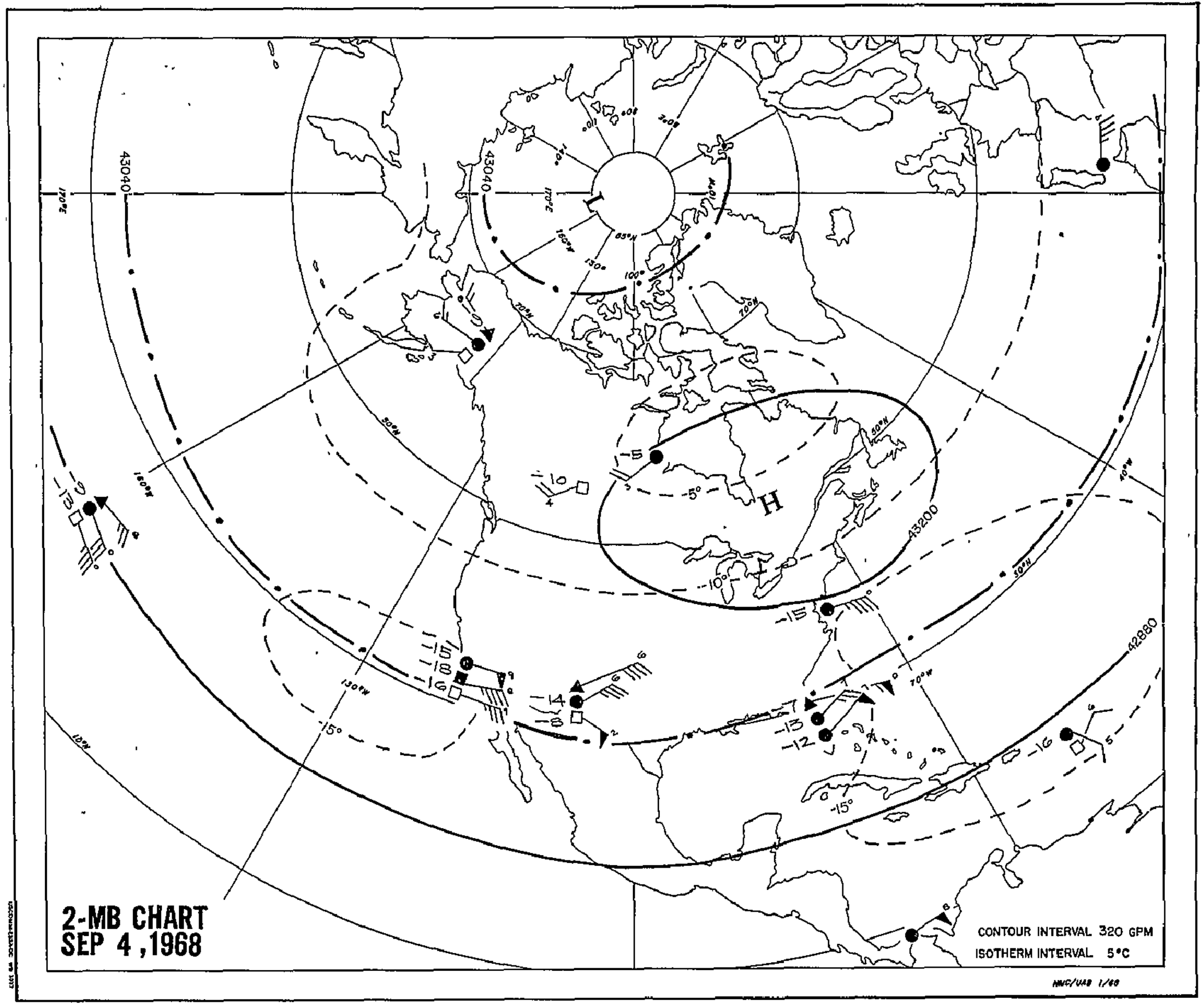
H
36480
36640
36160
36000
-30°
-25°
5-MB CHART
AUG 28,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C



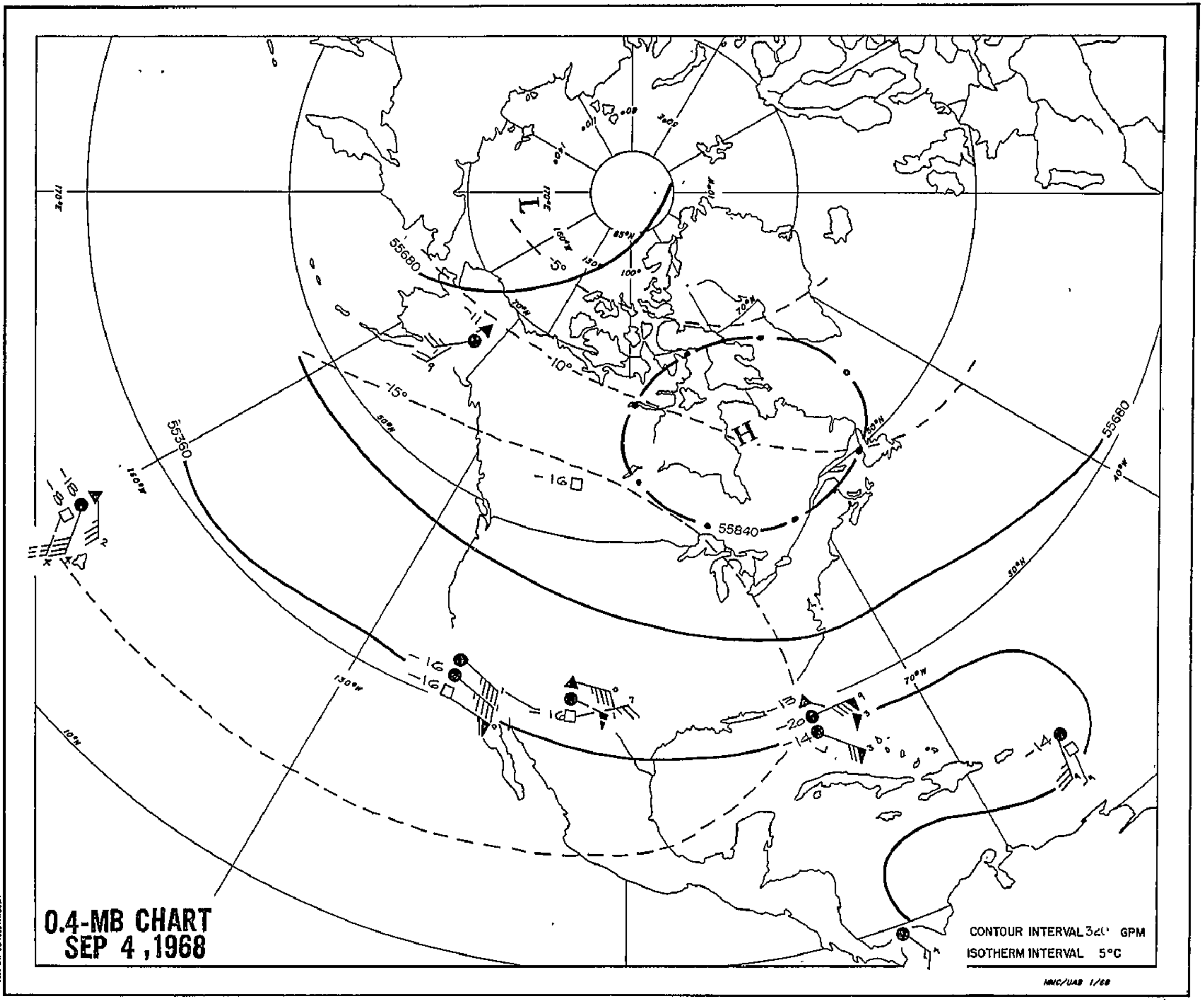
2-MB CHART
AUG 28, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
43200
43520
42880
H
-15°
-10°
-5°
HMC/UAB 1/68


0.4 -MB CHART
AUG 28,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
56320
56000
55680
53600
-10°
-15°
H

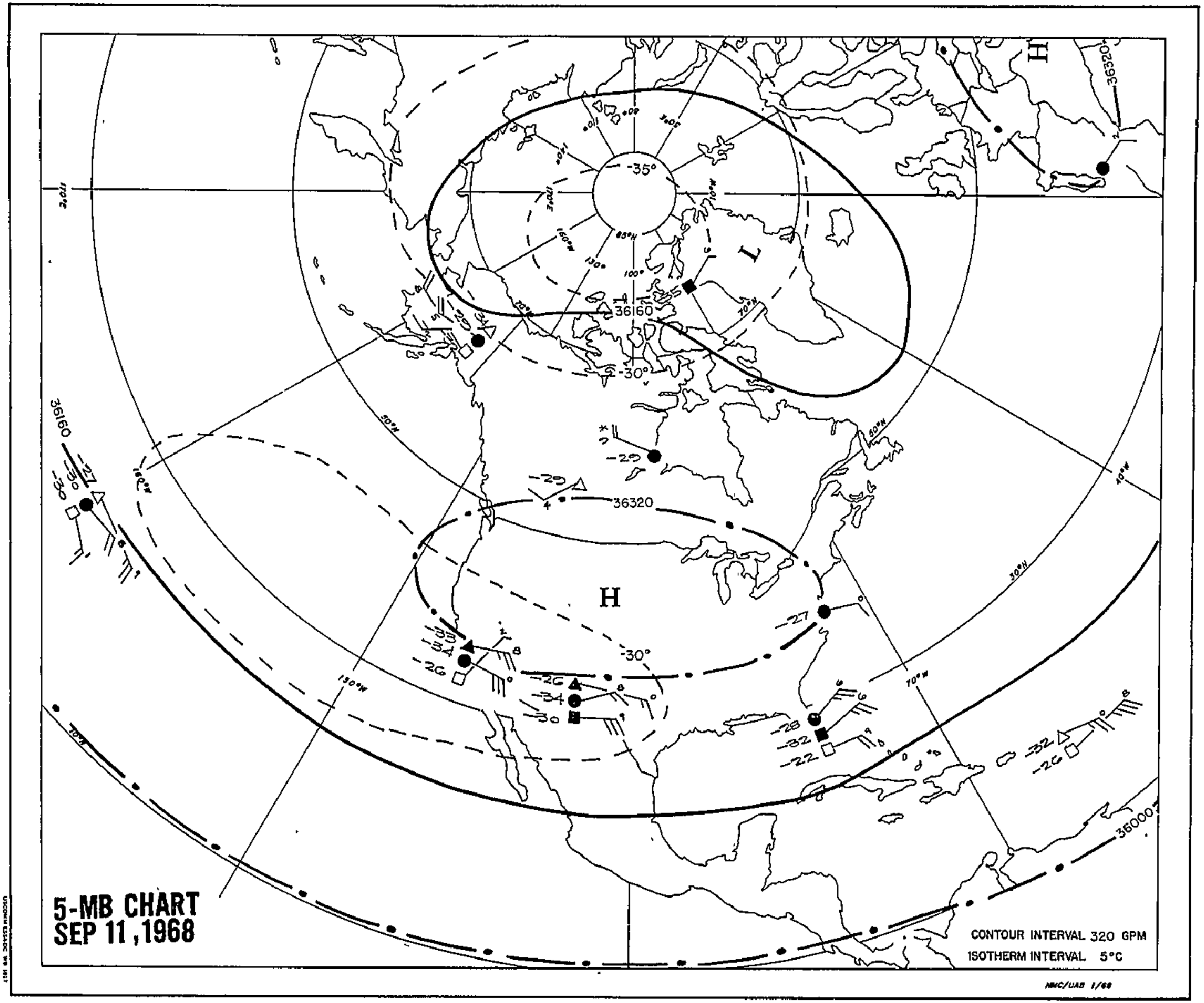

5-MB CHART
SEP 4 ,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
36400
36320
36160
36000
-25°
-30°
H
L

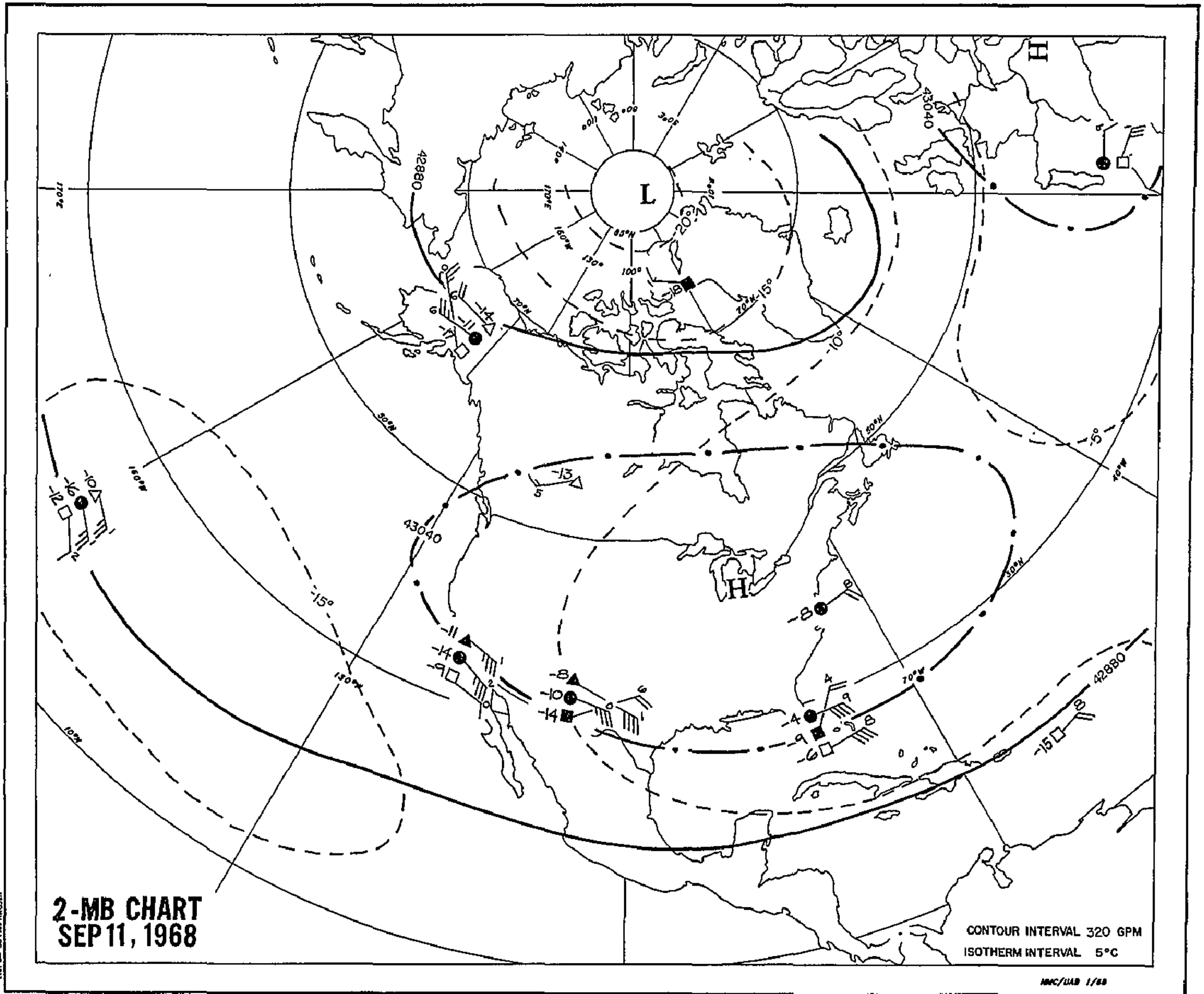

2-MB CHART
SEP 4 ,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
43040
43200
42880
H
L
-5°
-10°
-15°
NWC/UAB 1/69

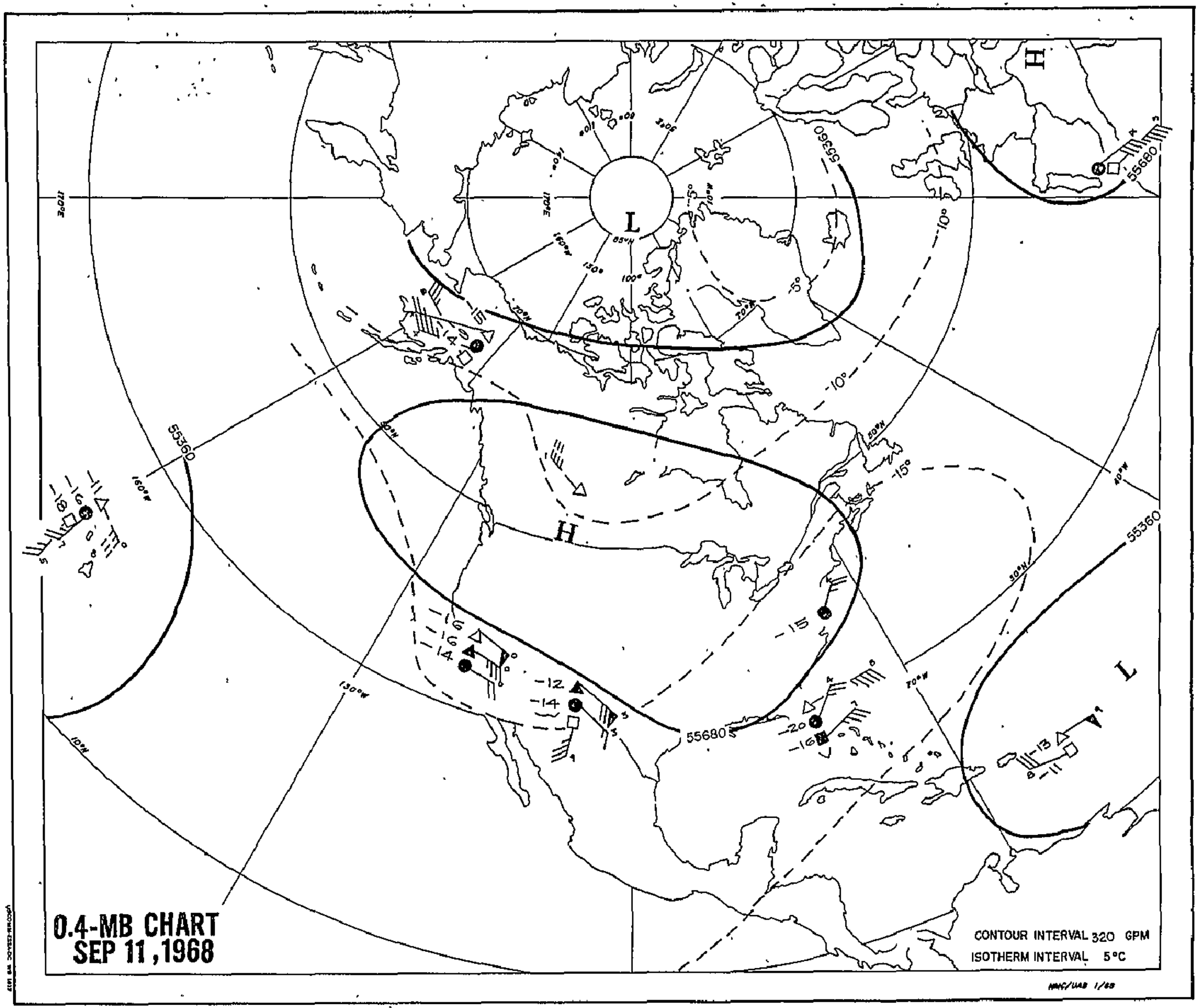
121

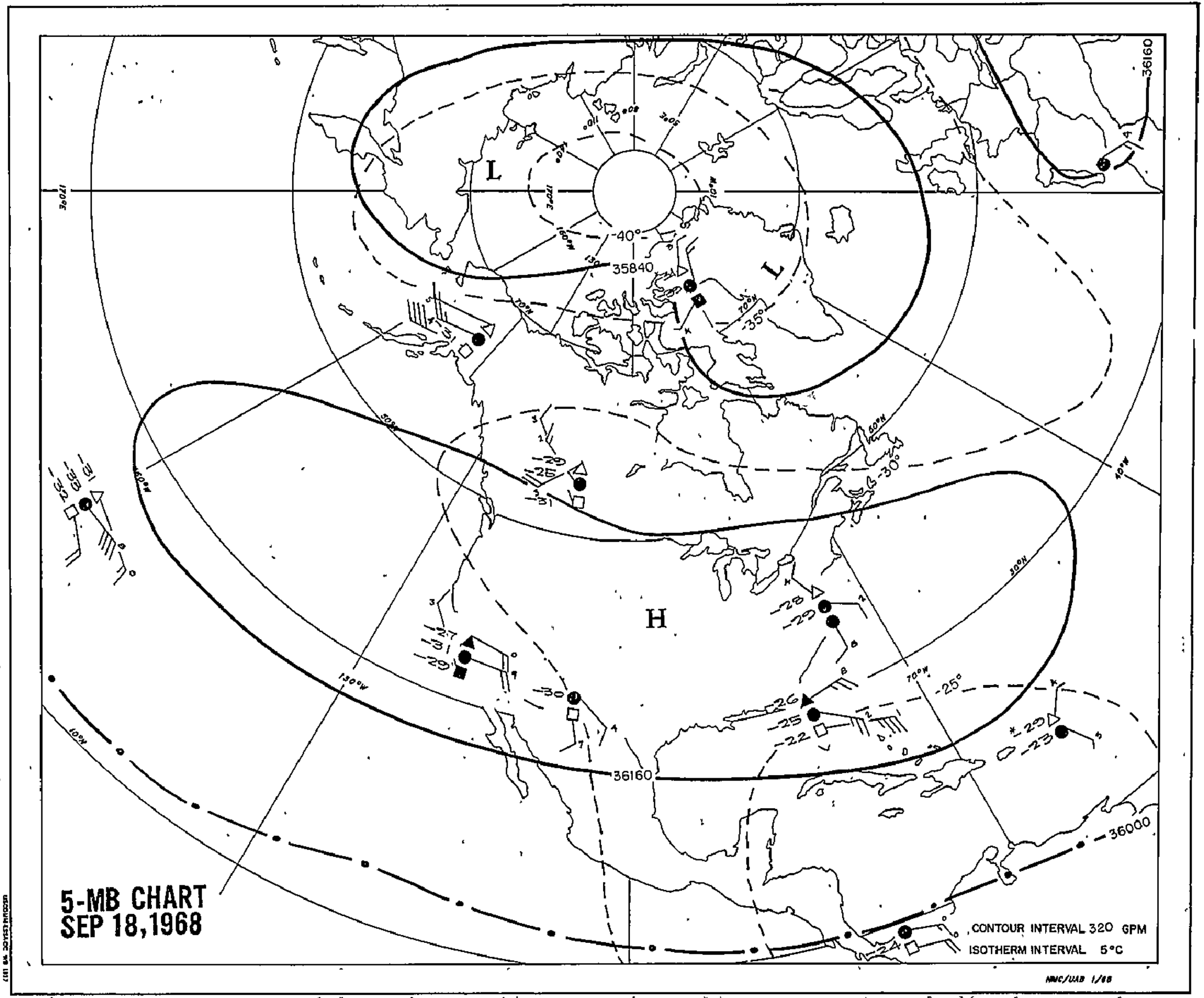


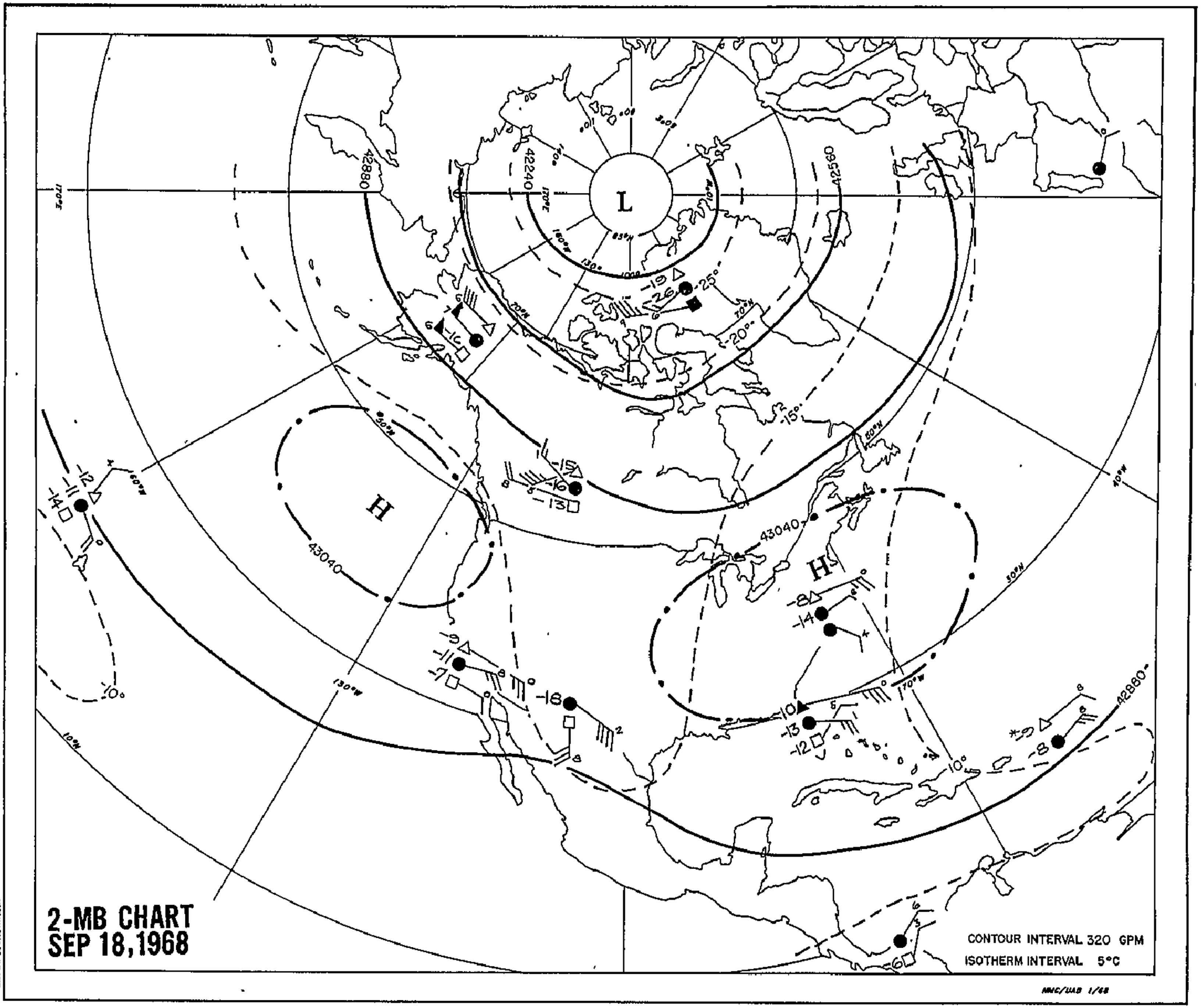
0.4-MB CHART
SEP 4 ,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
L
H
55680
55360
55840
55680
-5°
-10°
-15°
NMC/UAB 1/68

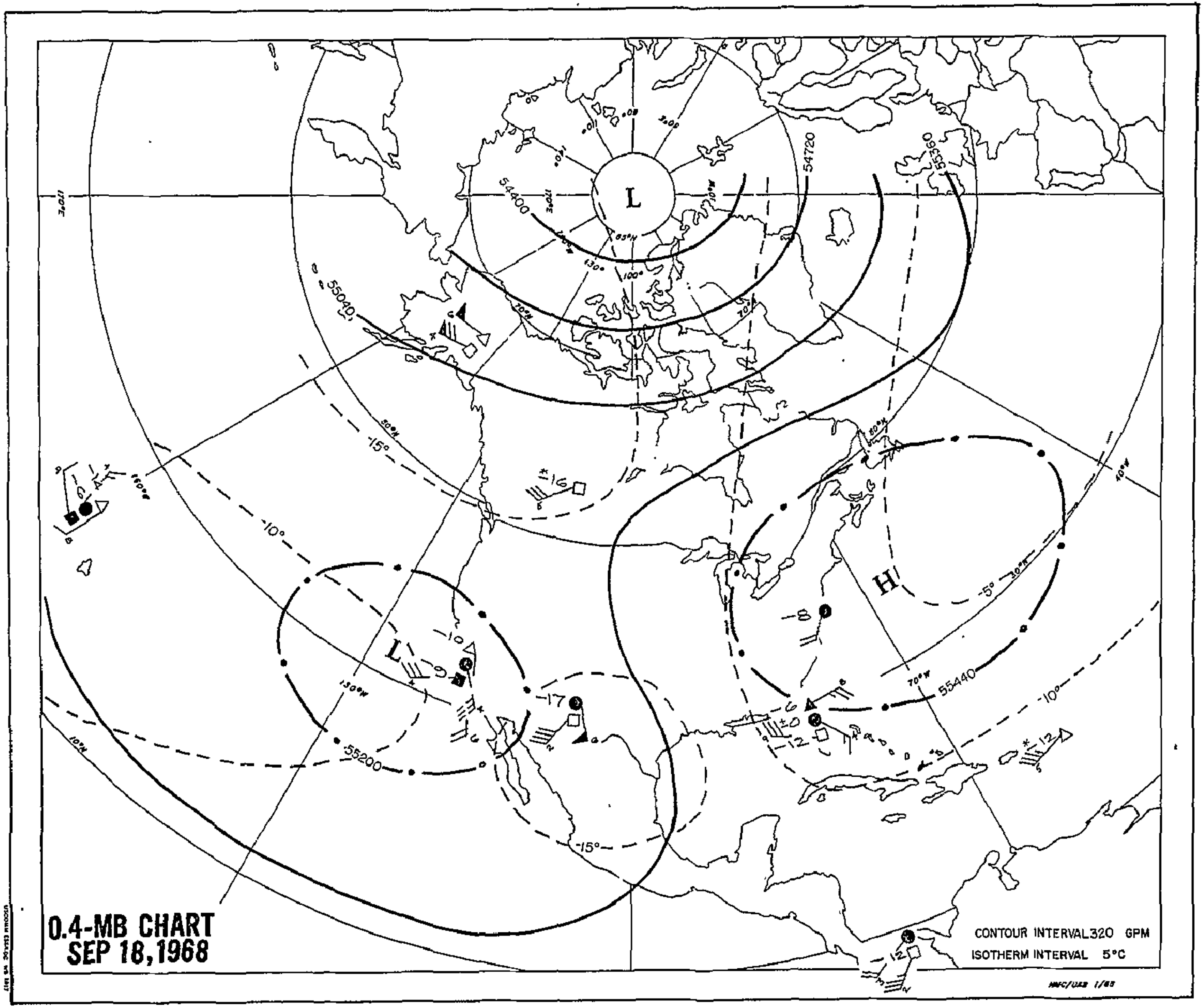

5-MB CHART
SEP 11,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
36320
36160
36000
-35°
-30°
H
L

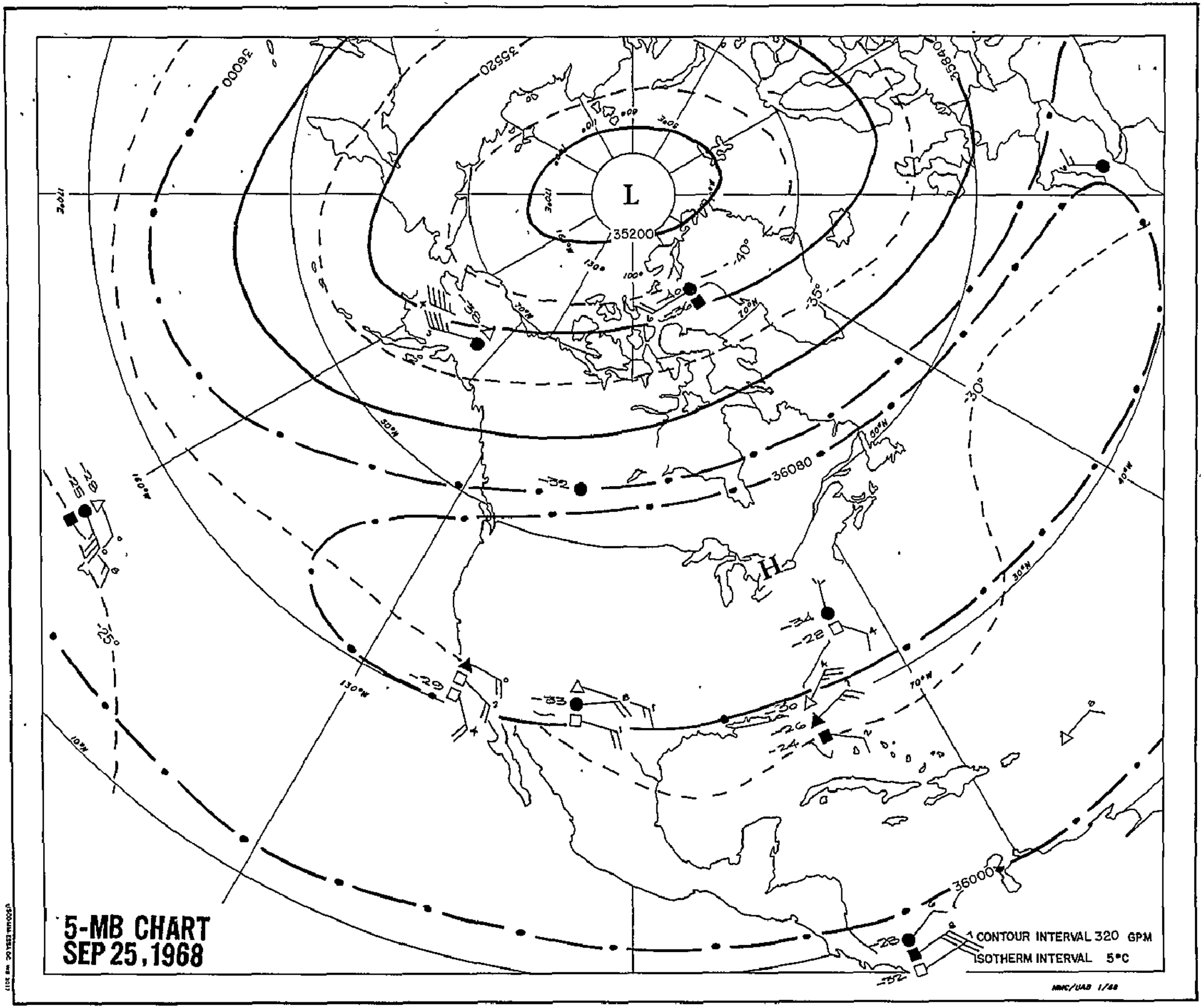

2-MB CHART
SEP 11, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
NMC/UAB 1/68
L
H
H
42880
43040
43040
42880
-20°
-15°
-10°
-5°
-15°

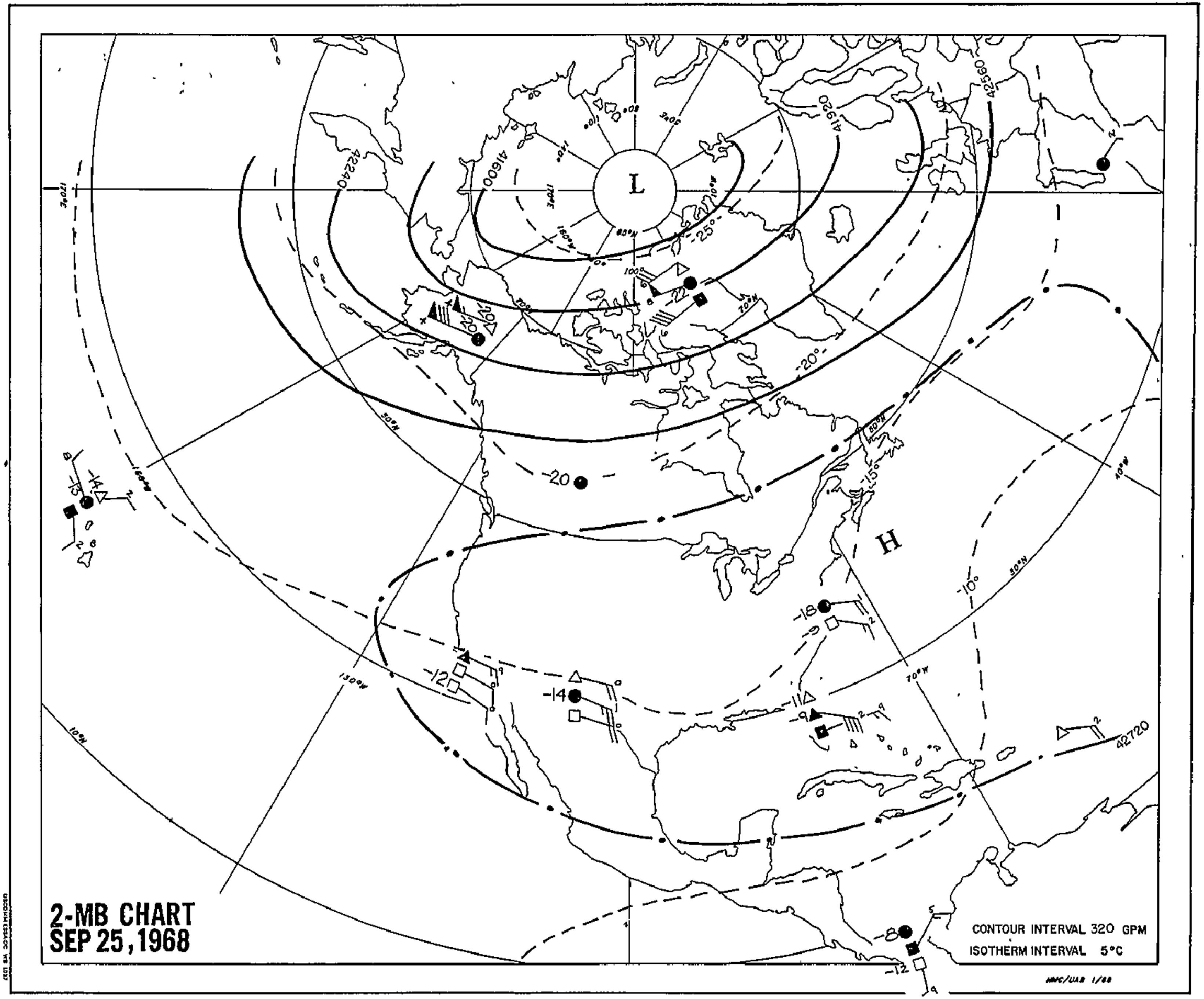

0.4-MB CHART
SEP 11, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
55360
55680
H
L
-5°
-10°
-15°

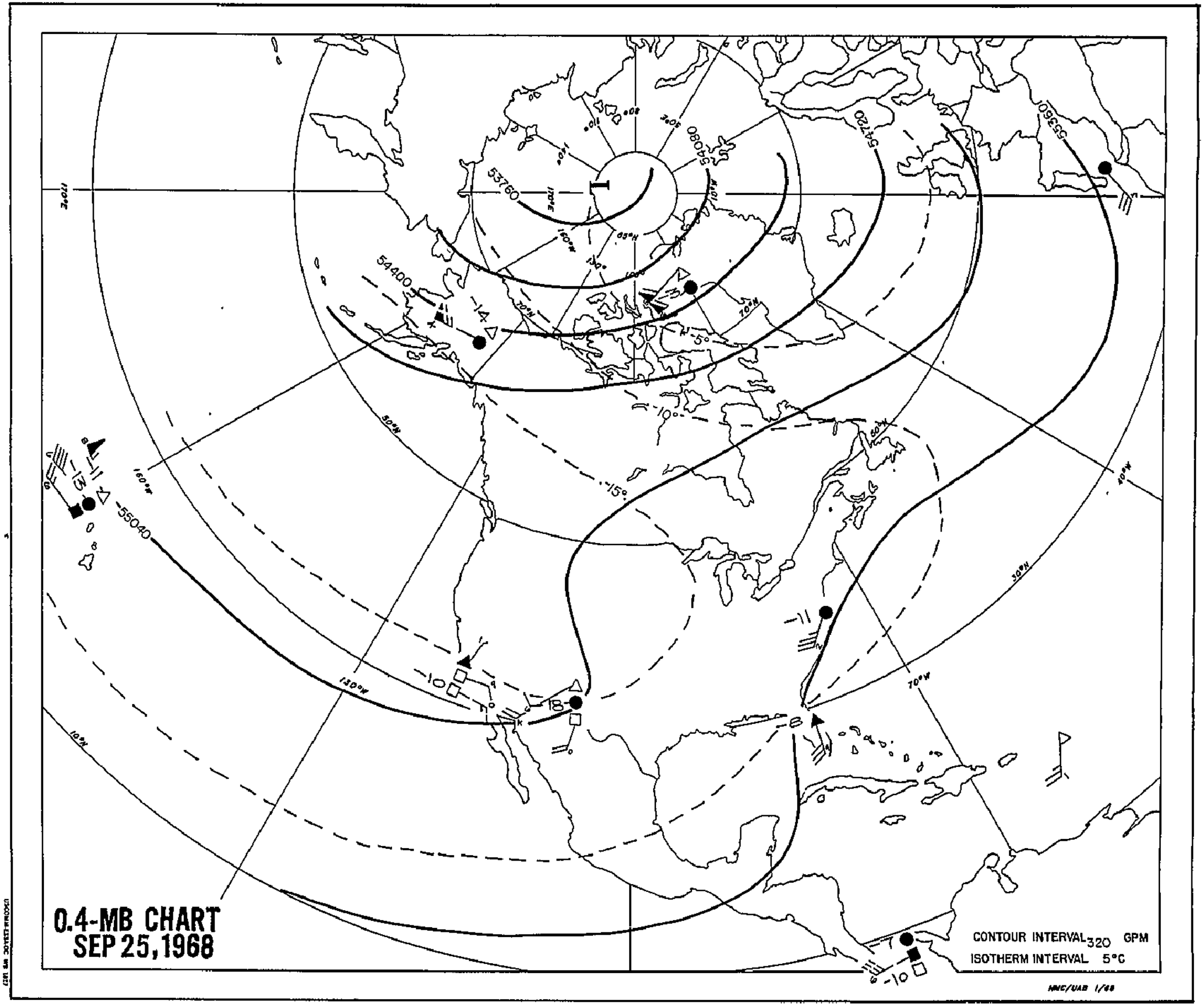

5-MB CHART
SEP 18,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
L
L
H
35840
36160
36160
36000
-40°
-35°
-30°
-25°
NMC/UAB 1/68

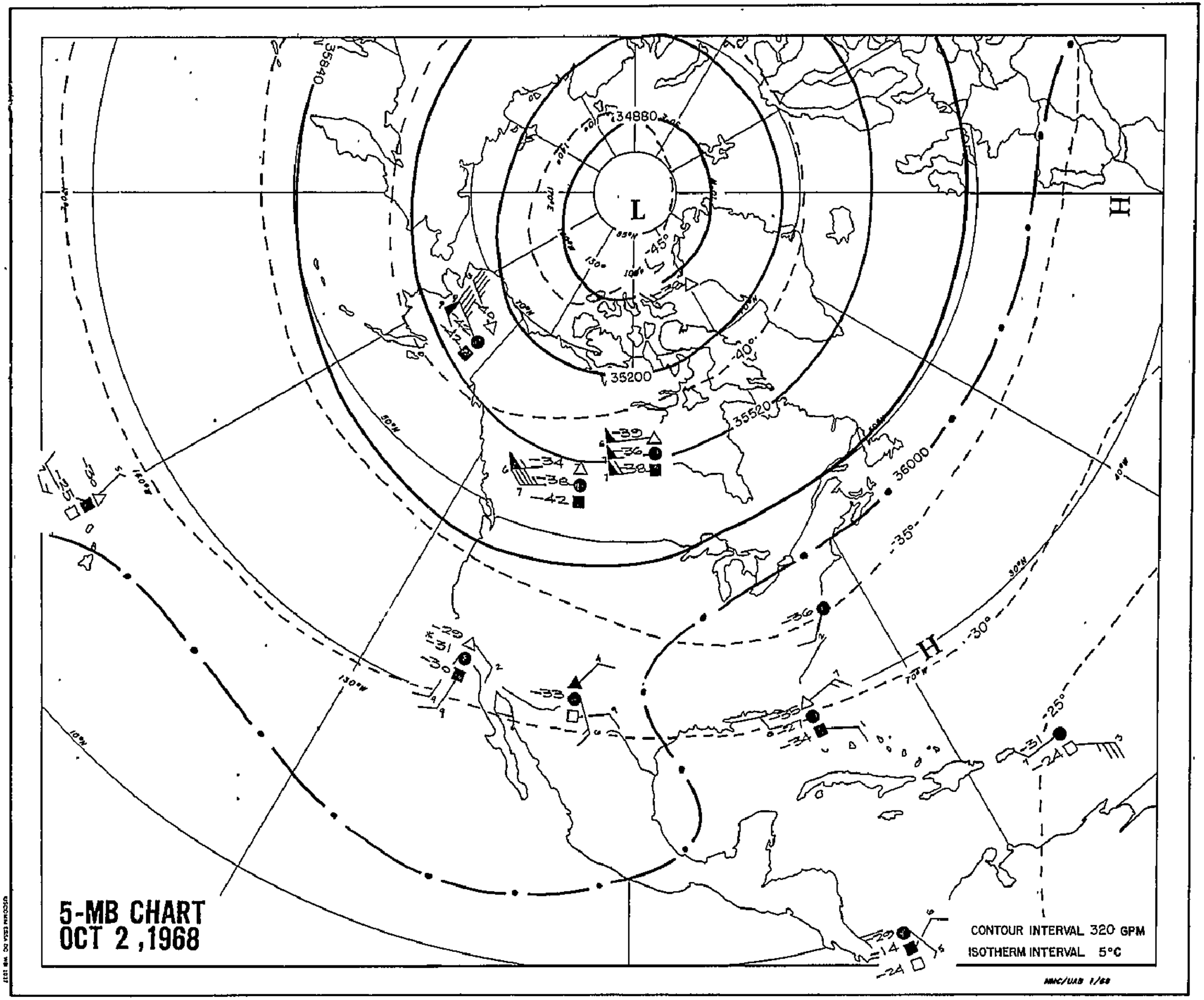

2-MB CHART
SEP 18,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
L
H
H
42880
42240
42560
43040
43040
42880
-25°
-20°
-15°
-10°
-10°
130°W
70°W
MWC/UAB 1/68

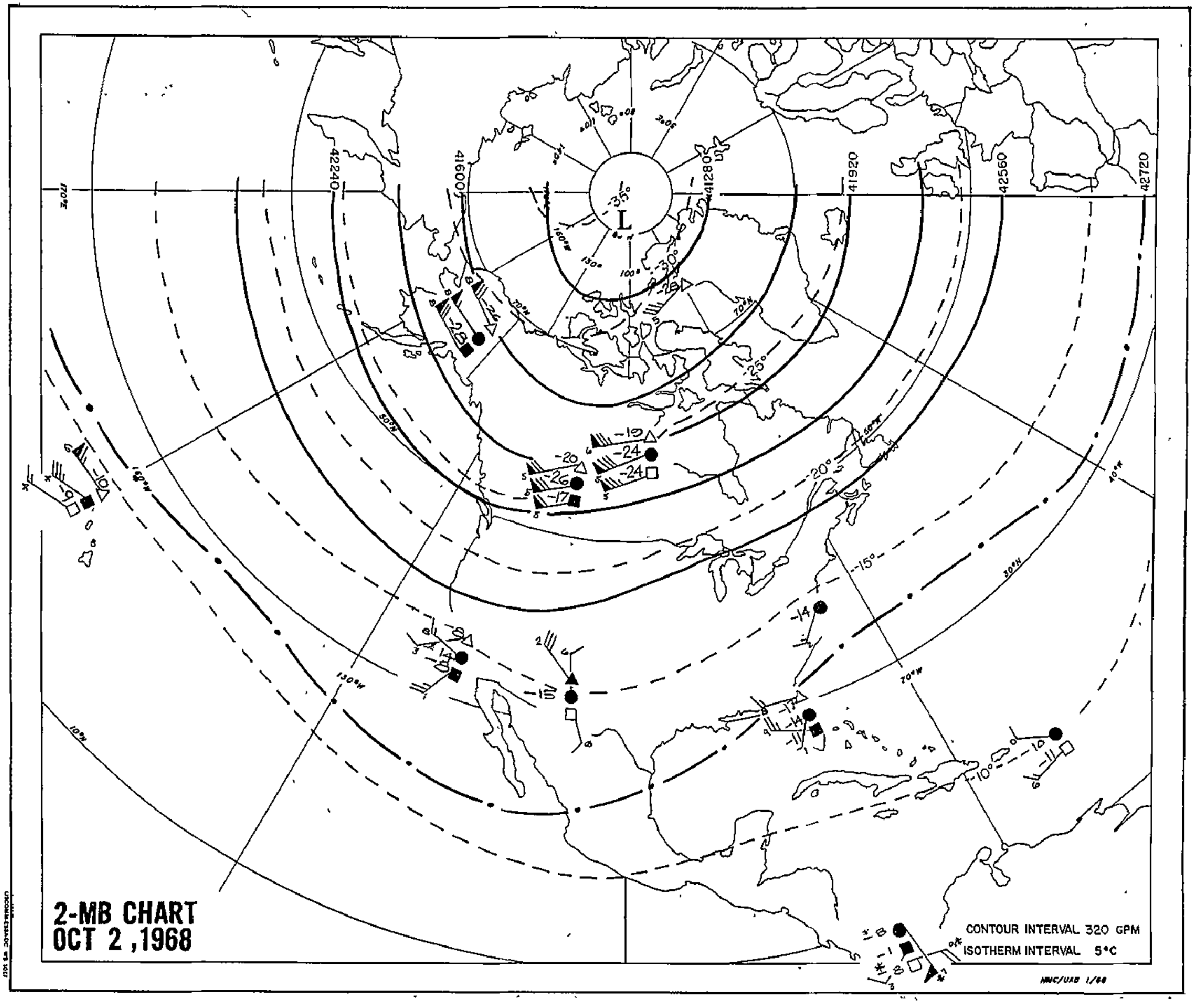

0.4-MB CHART
SEP 18,1968
CONTOUR INTERVAL320 GPM
ISOTHERM INTERVAL 5°C
L
H
54400
54720
55360
55040
55200
55440
-15°
-10°
-5°

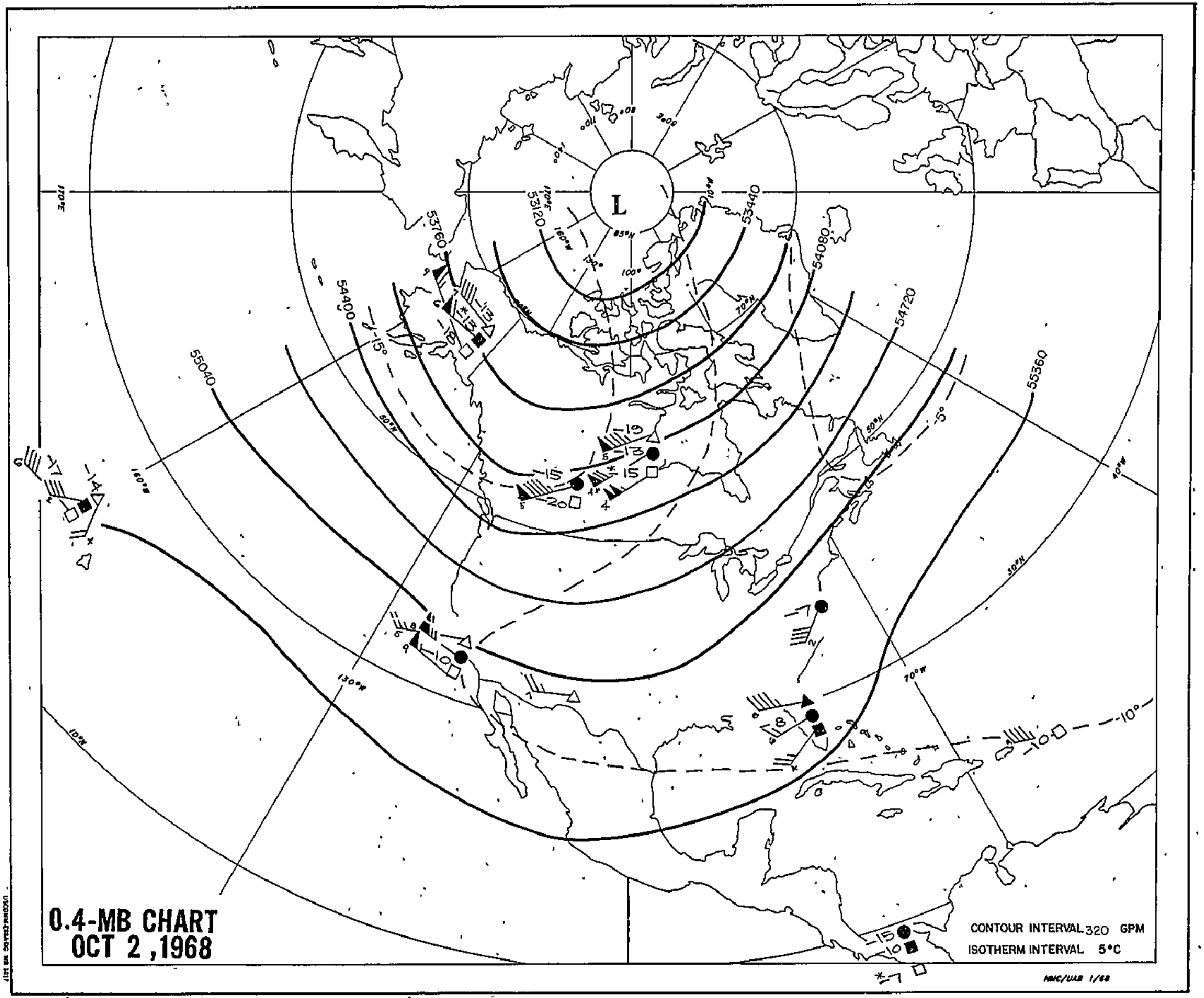

L
H
35200
35520
35840
36000
36080
36000
-40°
-35°
-30°
-25°
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
5-MB CHART
SEP 25, 1968

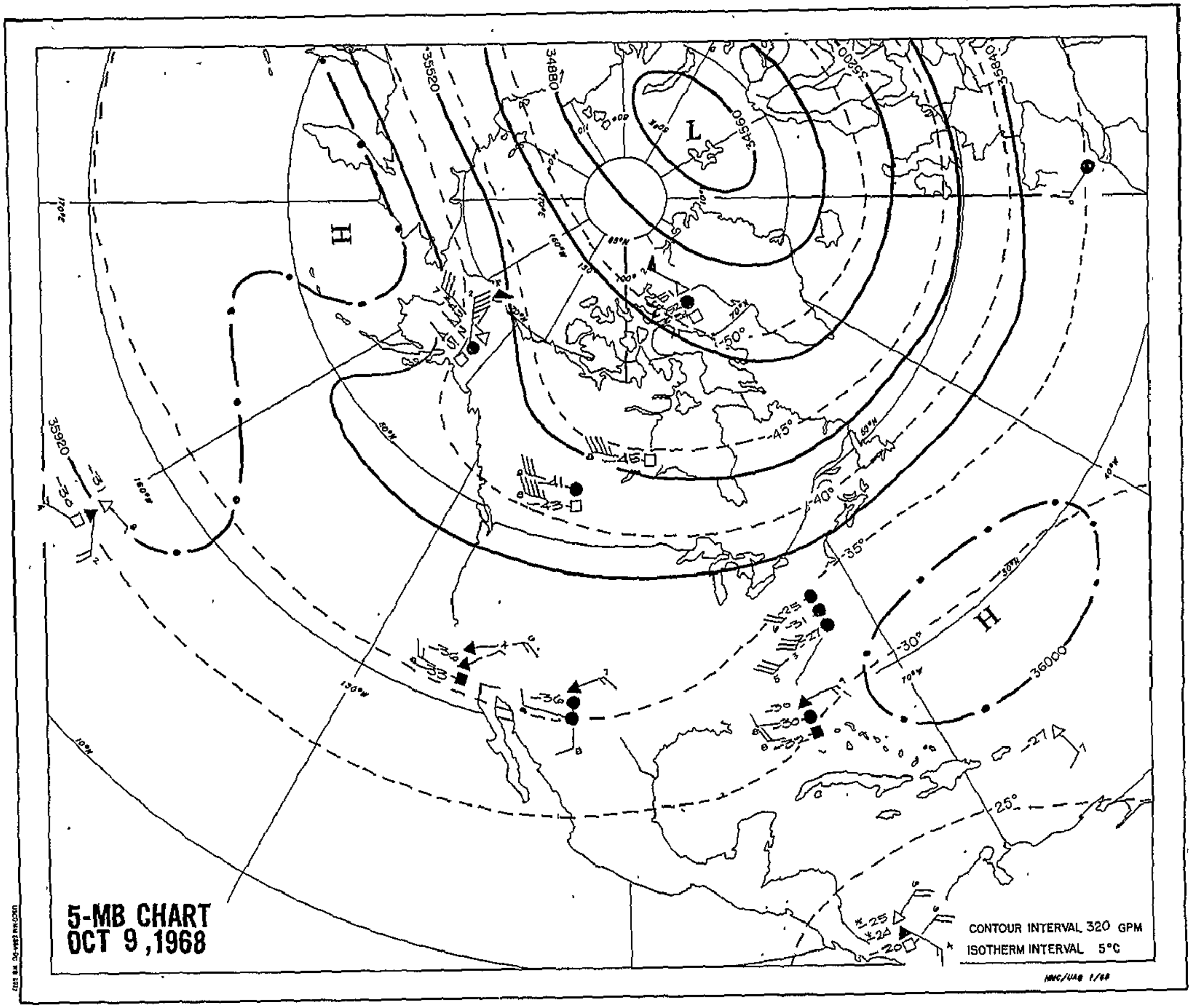

2-MB CHART
SEP 25,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
L
H
41600
41920
42240
42560
42720
-25°
-20°
-15°
-10°

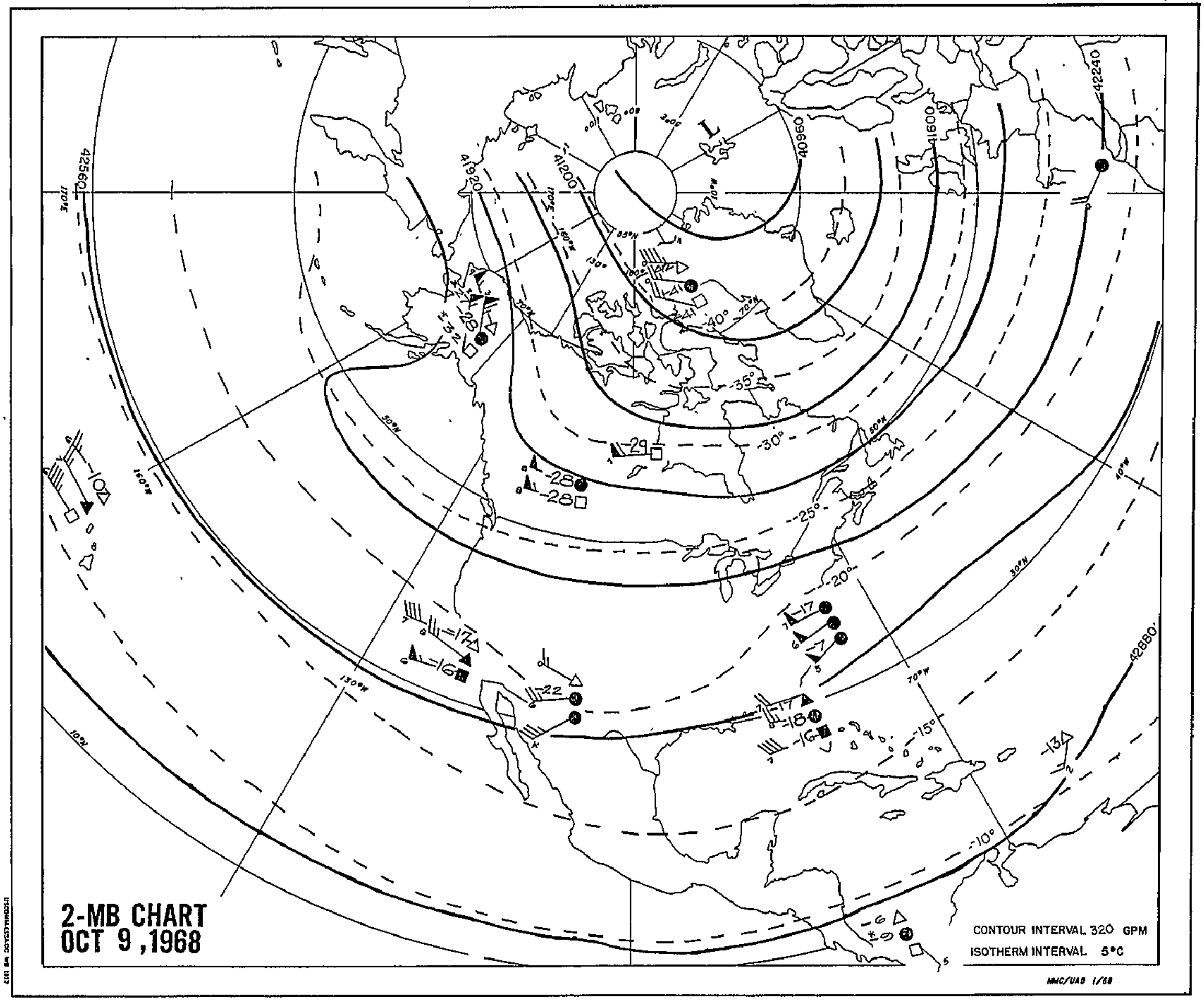

0.4-MB CHART
SEP 25,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
53760
54080
54400
54720
55040
55360
-5°
-10°
-15°

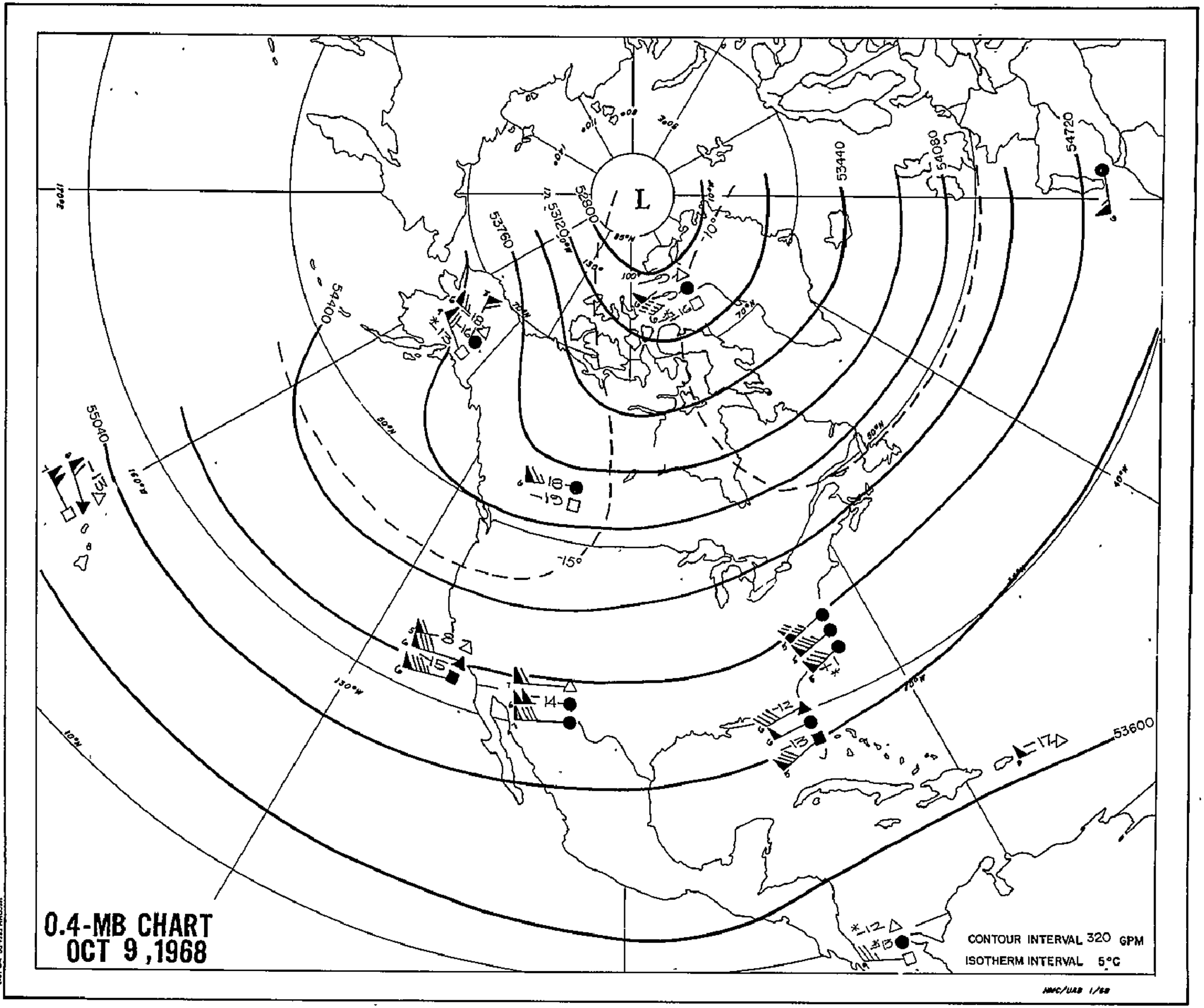

5-MB CHART
OCT 2 ,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
L
H
H
34880
35200
35520
35840
36000
-45°
-40°
-35°
-30°
-25°

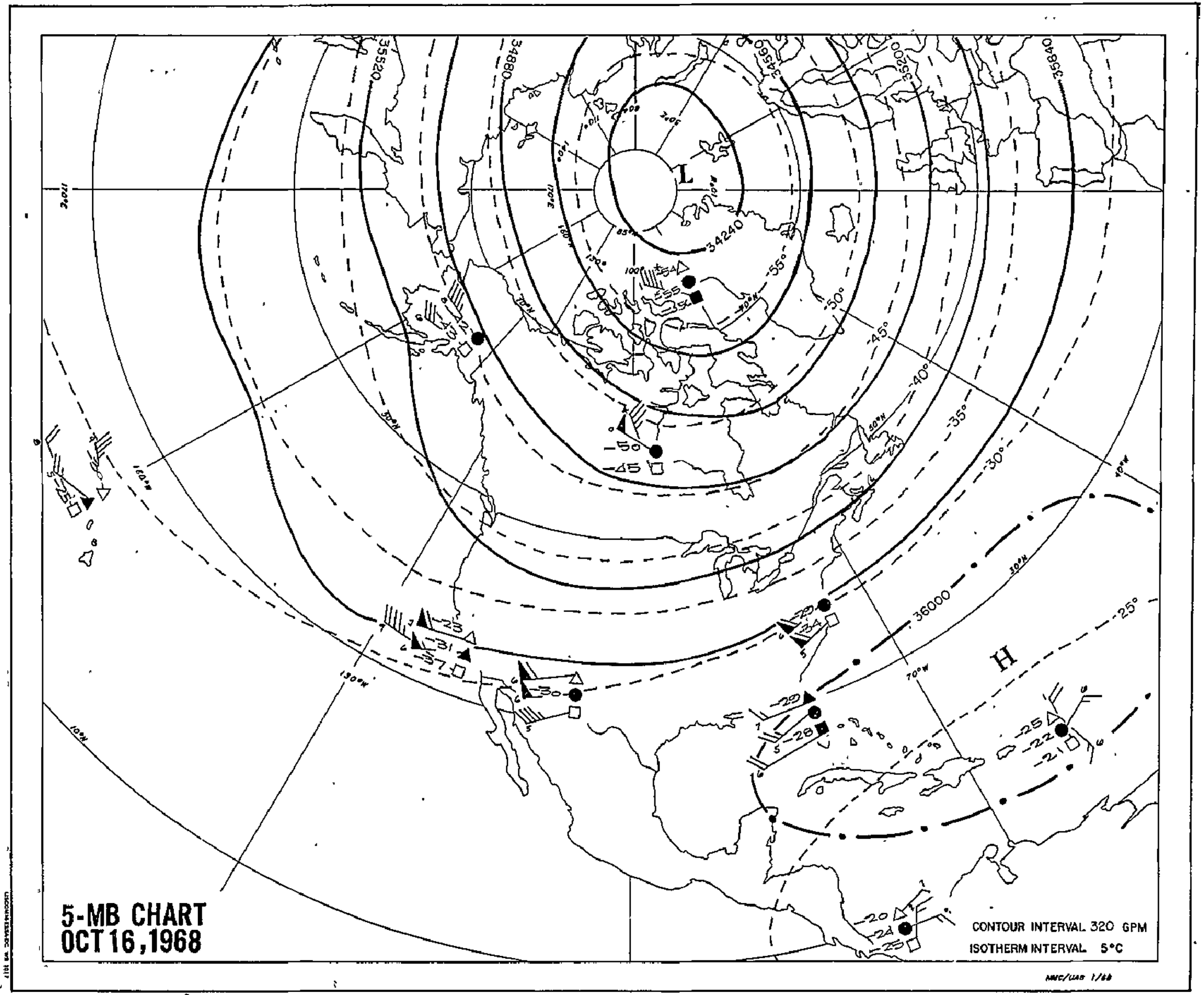

2-MB CHART
OCT 2 ,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
42240
41600
41280
41920
42560
42720
L
-35°
-30°
-25°
-20°
-15°
-10°
NMC/UAB 1/68


0.4-MB CHART
OCT 2 ,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
L
53120
53440
53760
54080
54400
54720
55040
55360

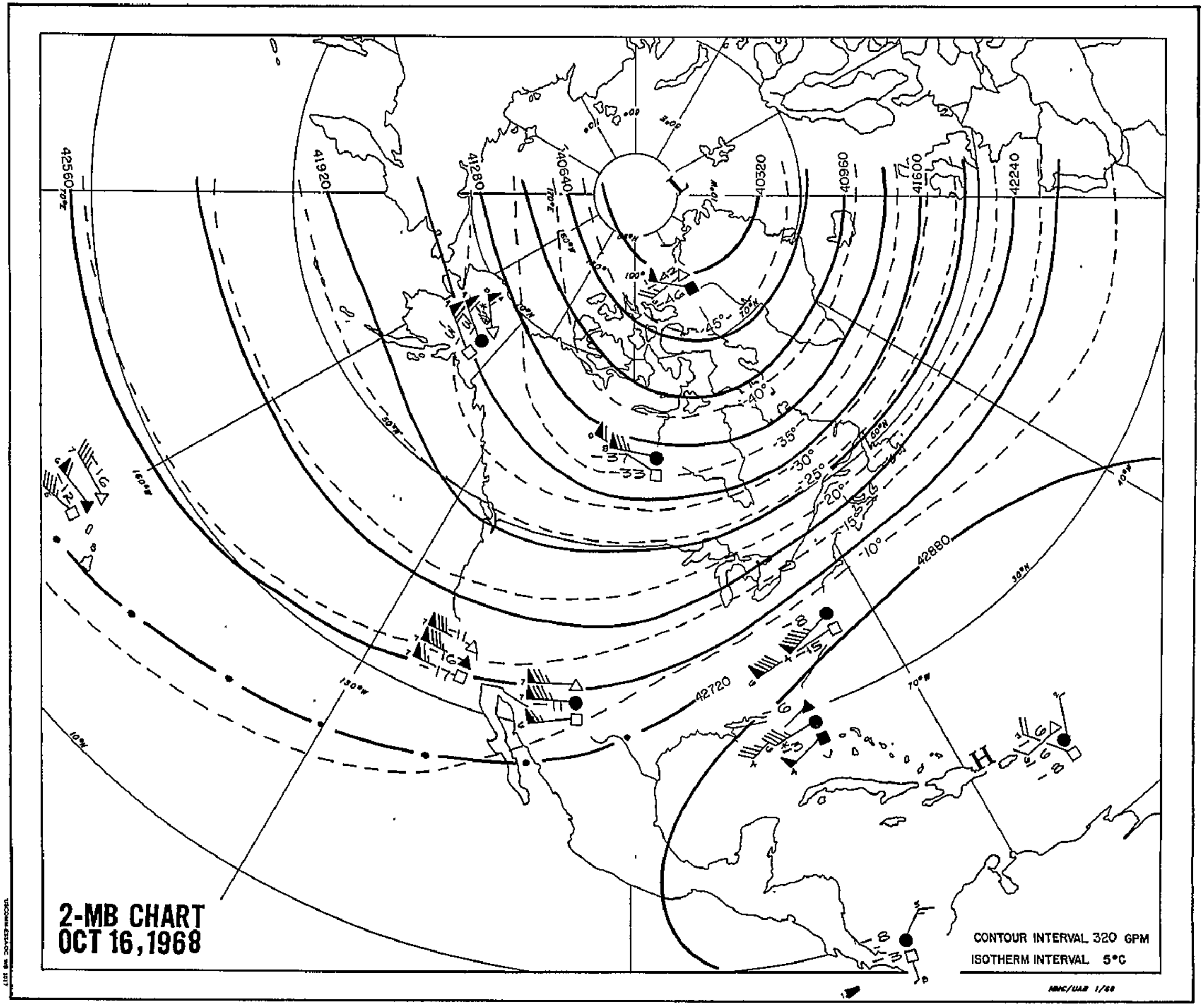

5-MB CHART
OCT 9 ,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
L
H
H
34560
34880
35200
35520
35840
35920
36000
-50°
-45°
-40°
-35°
-30°
25°

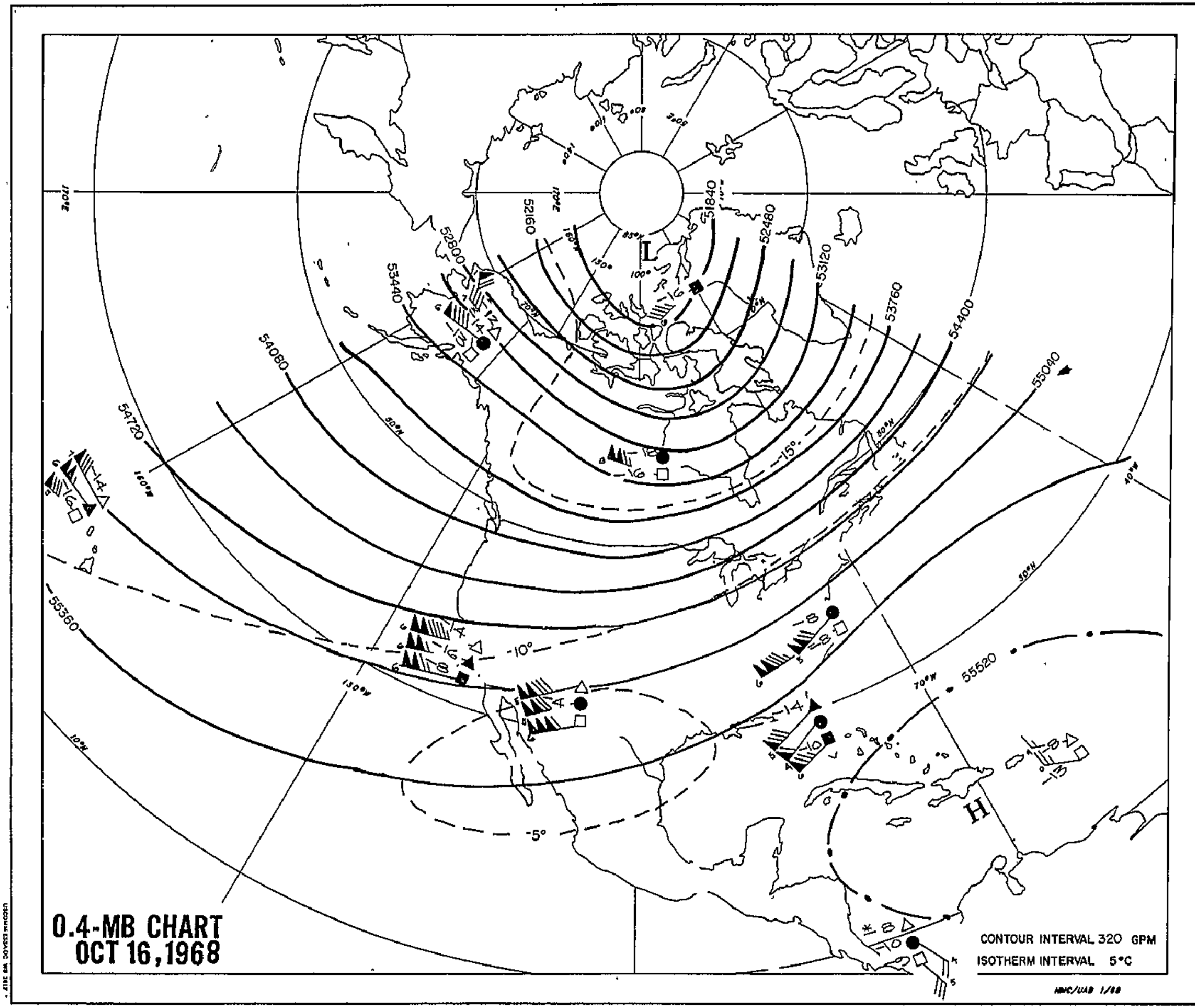

2-MB CHART
OCT 9, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
NMC/UAB 1/68
40960
41600
42240
42880
41920
41200
42560
L
-40°
-35°
-30°
-25°
-20°
-15°
-10°

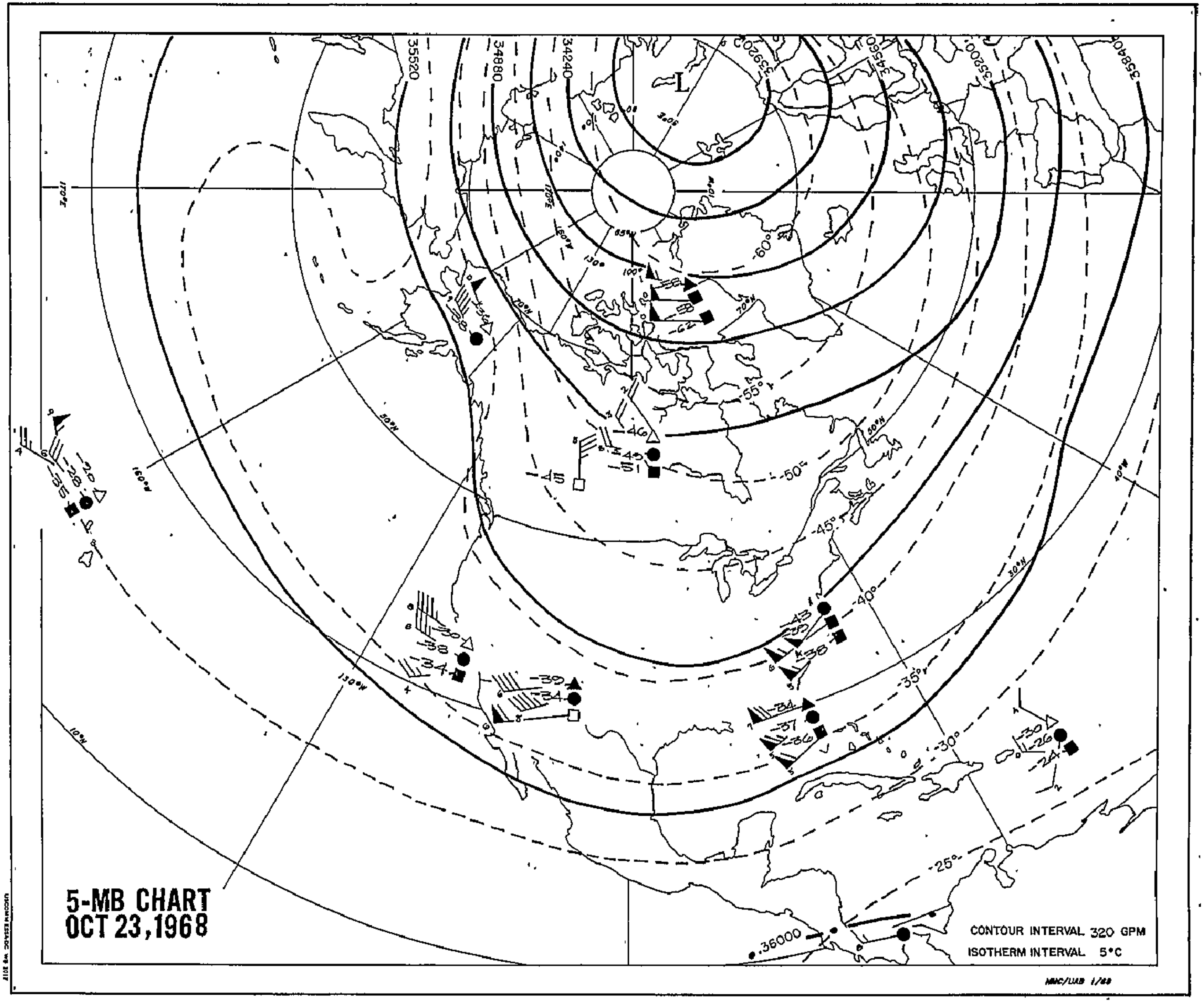

0.4-MB CHART
OCT 9 ,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
L
52800
53120
53440
53760
54080
54400
54720
55040
53600
-15°
-10°
NMC/UAB 1/68

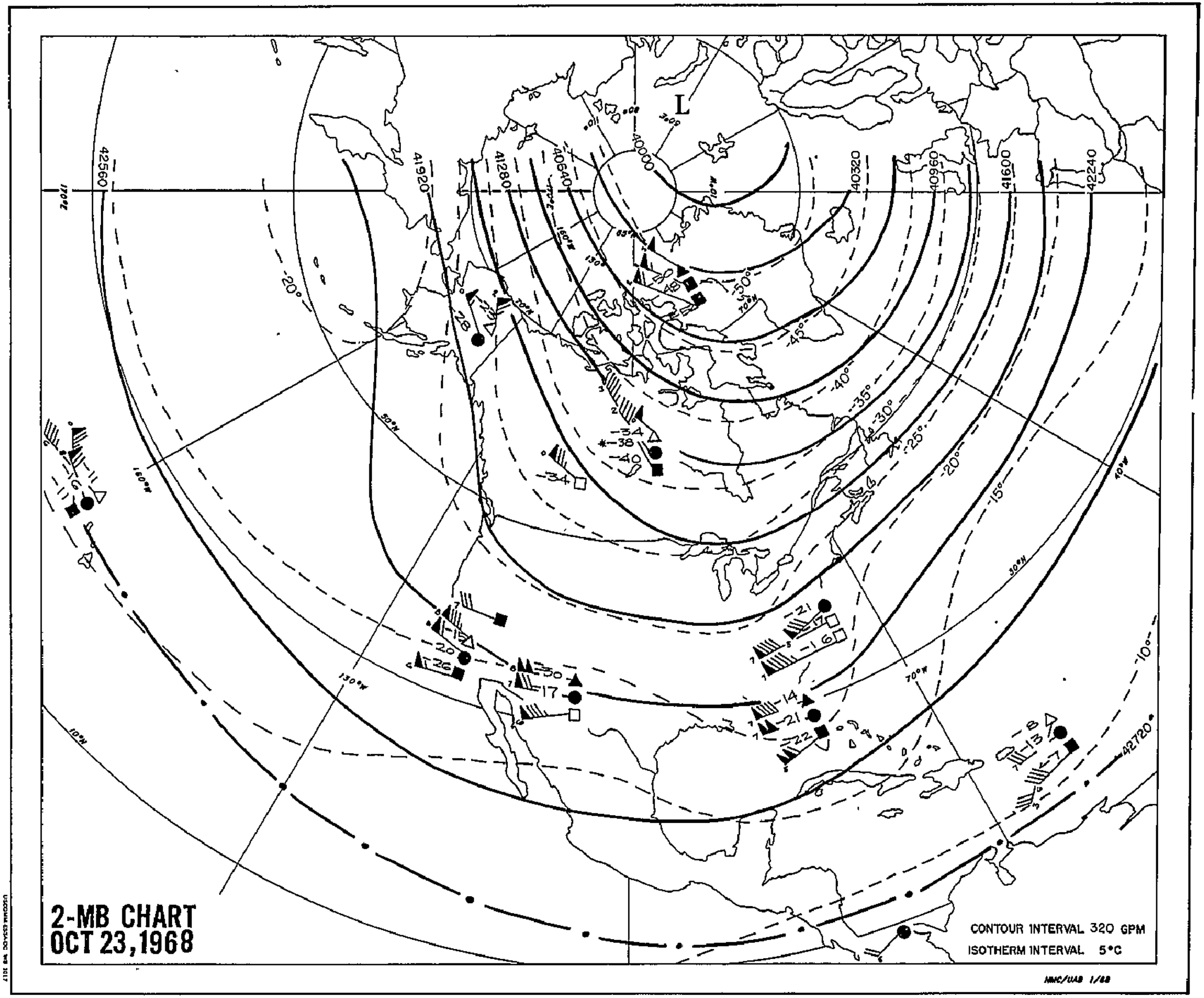


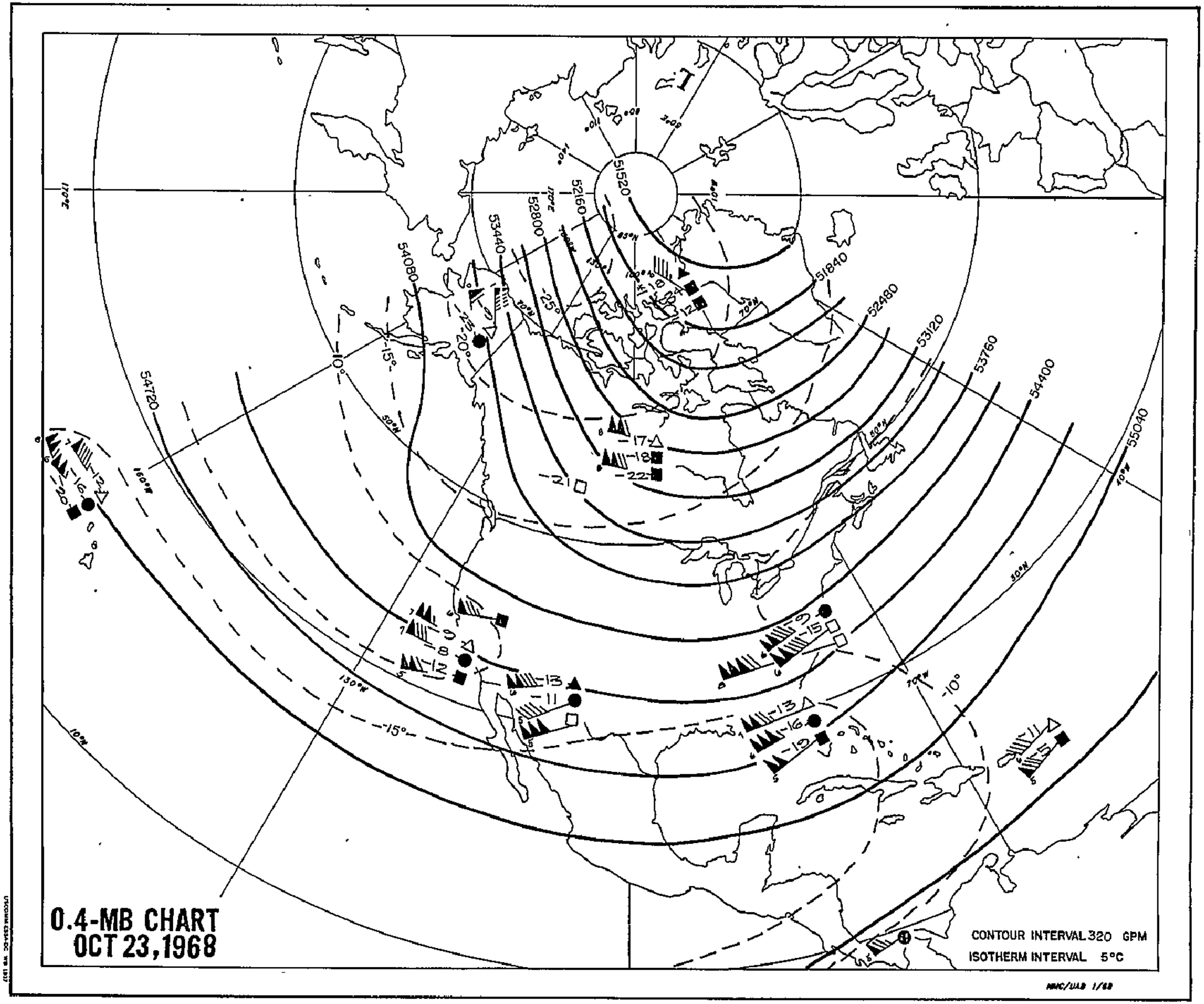
5-MB CHART
OCT 16,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
L
H
34240
34560
34880
35200
35520
35840
36000
-55°
-50°
-45°
-40°
-35°
-30°
-25°

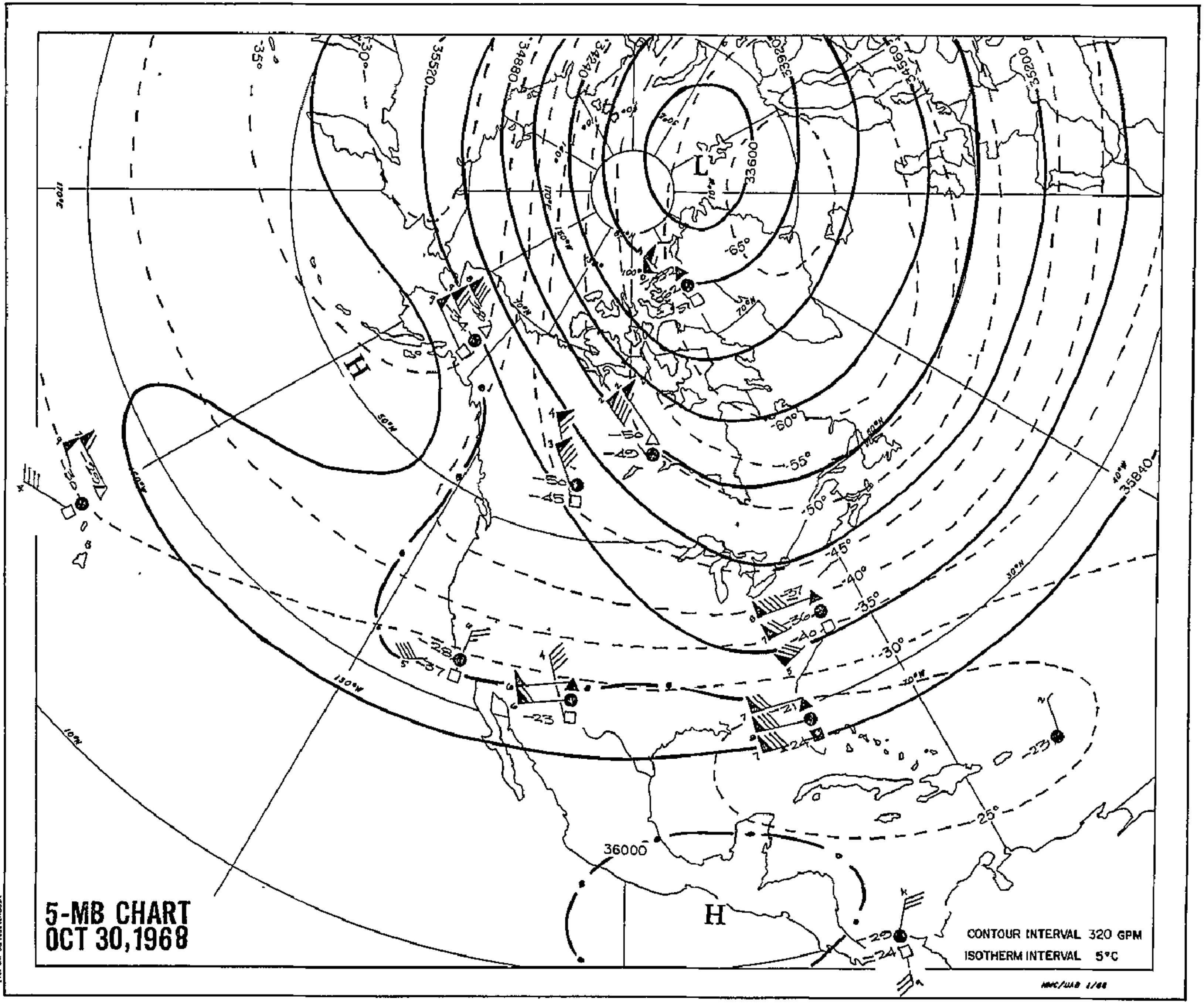

2-MB CHART
OCT 16, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
42560
41920
41280
40640
40320
40960
41600
42240
42880
42720
-45°
-40°
-35°
-30°
-25°
-20°
-15°
-10°
L
H

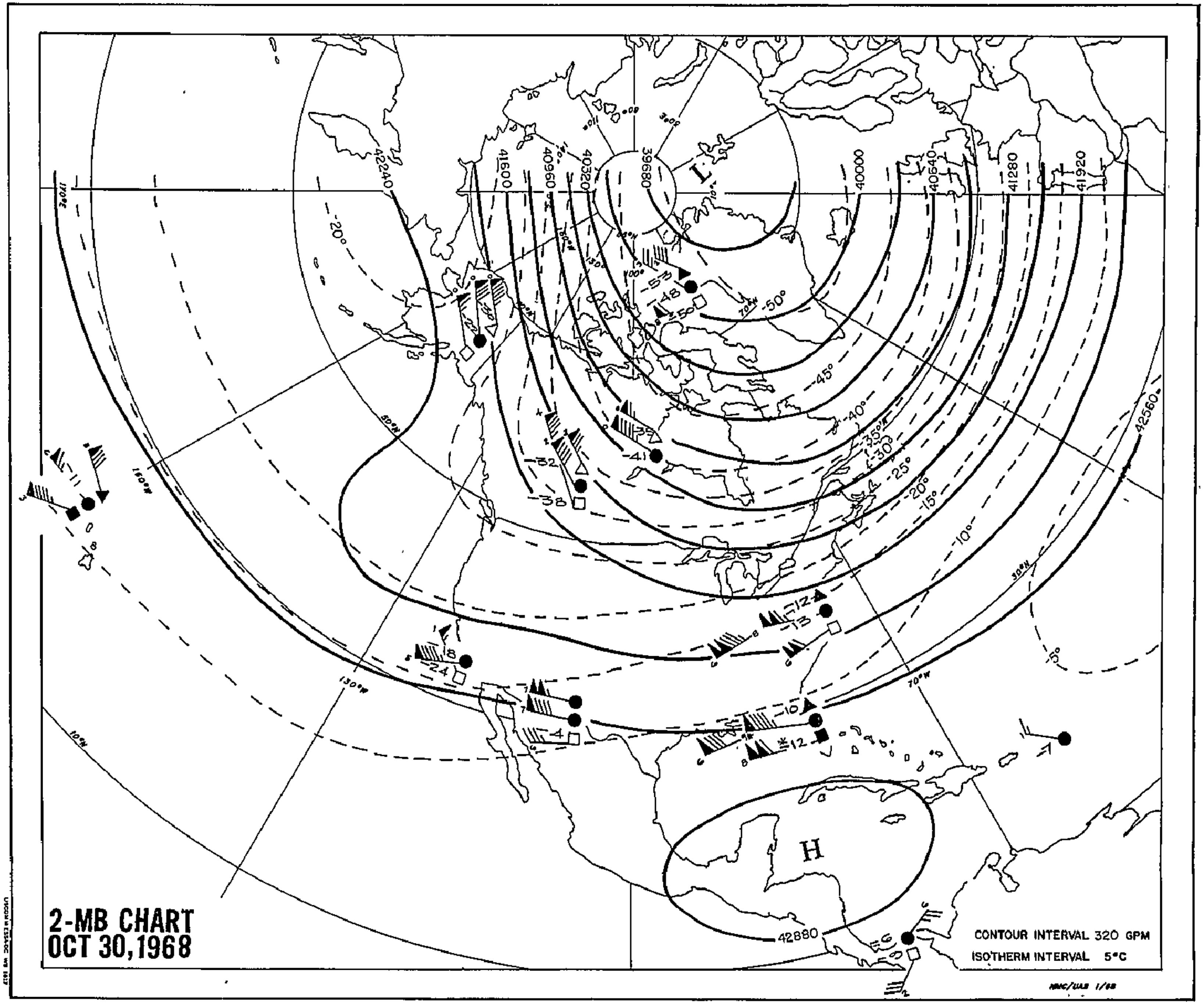

0.4-MB CHART
OCT 16,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
51840
52160
52480
52800
53120
53440
53760
54080
54400
54720
55040
55360
55520
-15°
-10°
-5°
L
H

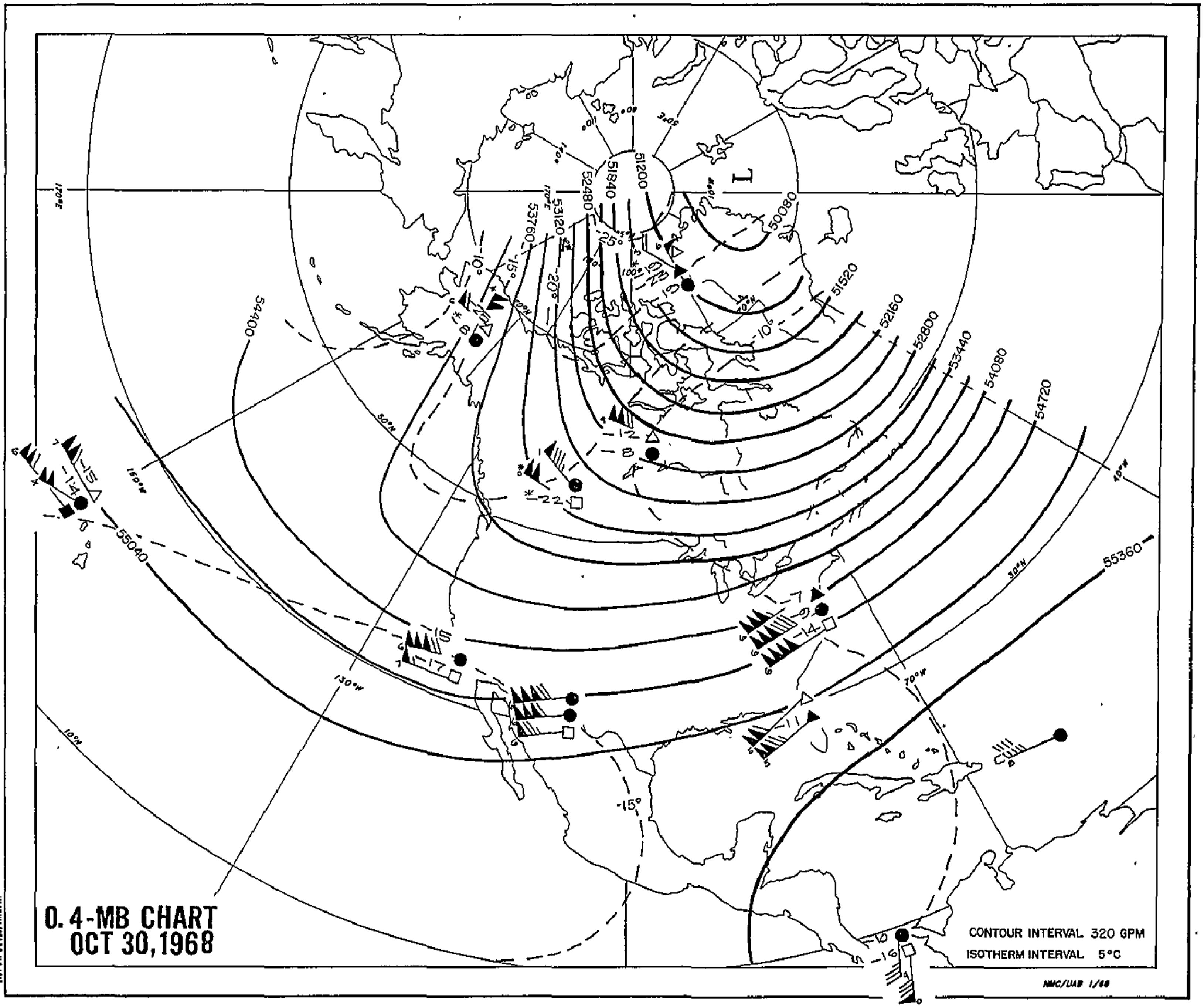

5-MB CHART
OCT 23,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
35520
34880
34240
33920
34560
35200
35840
36000
-60°
-55°
-50°
-45°
-40°
-35°
-30°
-25°
L

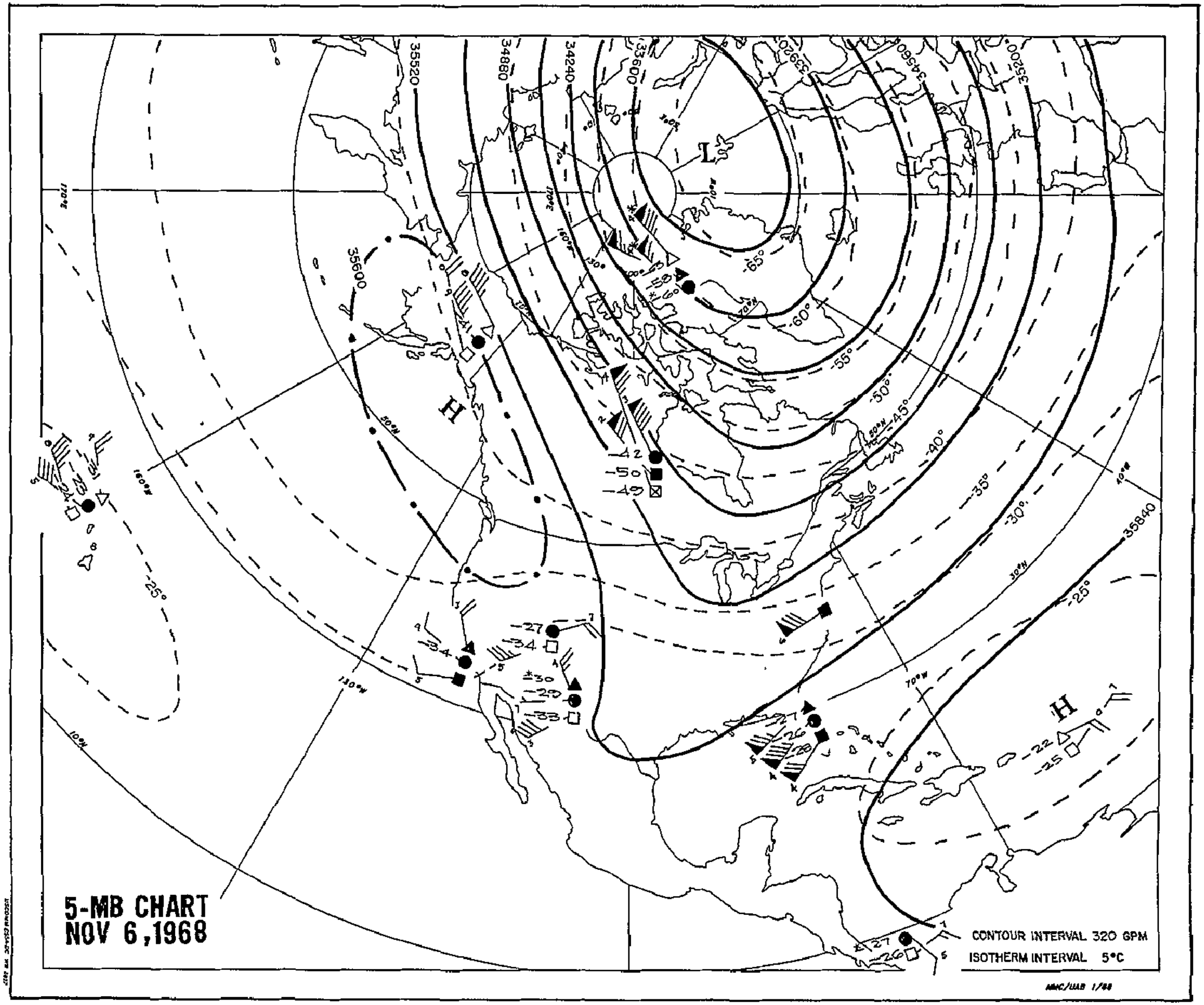

2-MB CHART
OCT 23,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
L
42560
41920
41280
40640
40000
40320
40960
41600
42240
42720
-20°
-50°
-45°
-40°
-35°
-30°
-25°
-20°
-15°
-10°
130°W
70°W
30°N
10°N

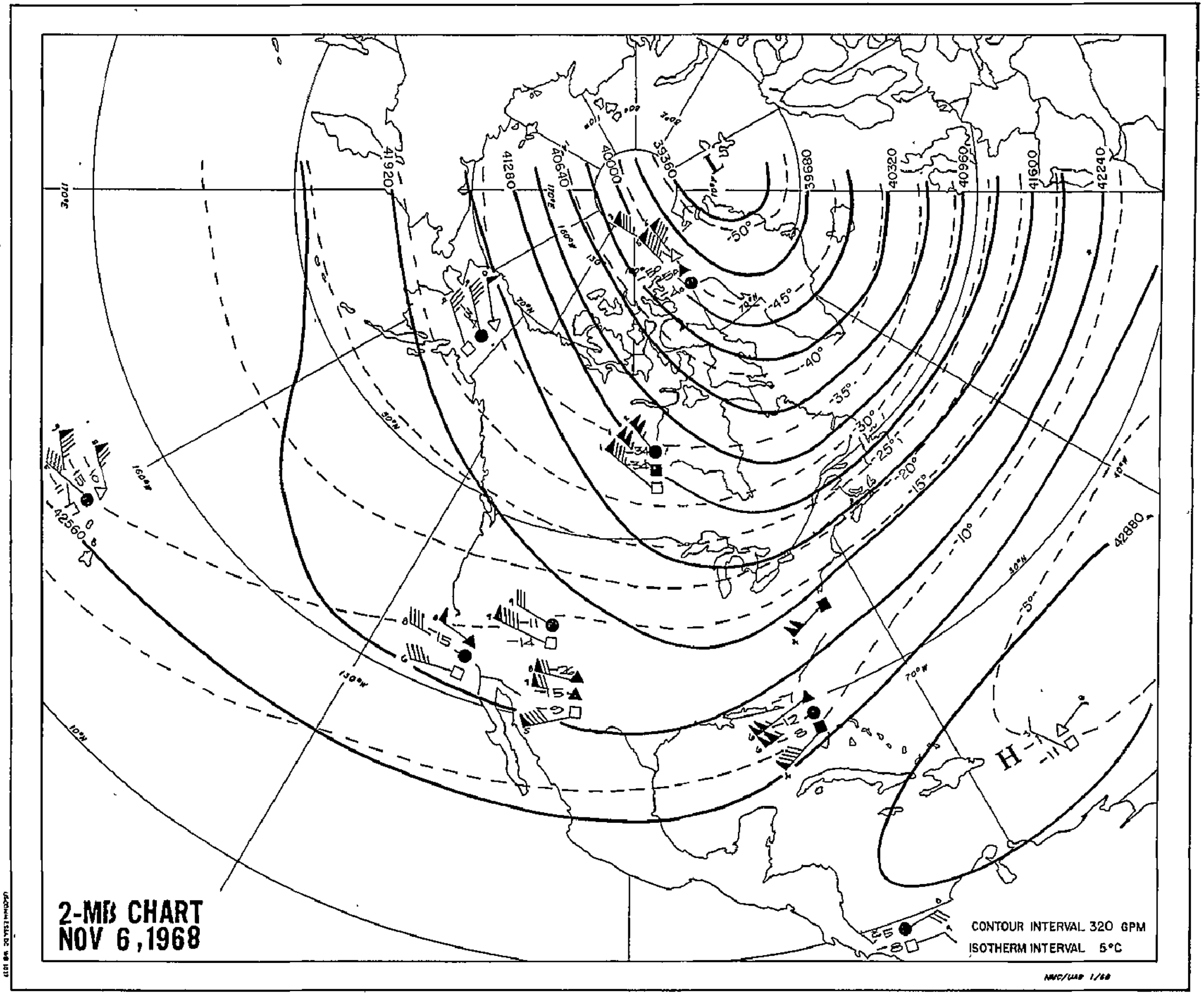

0.4-MB CHART
OCT 23,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
51520
51840
52160
52480
52800
53120
53440
53760
54080
54400
54720
55040
-10°
-15°
-20°
-25°

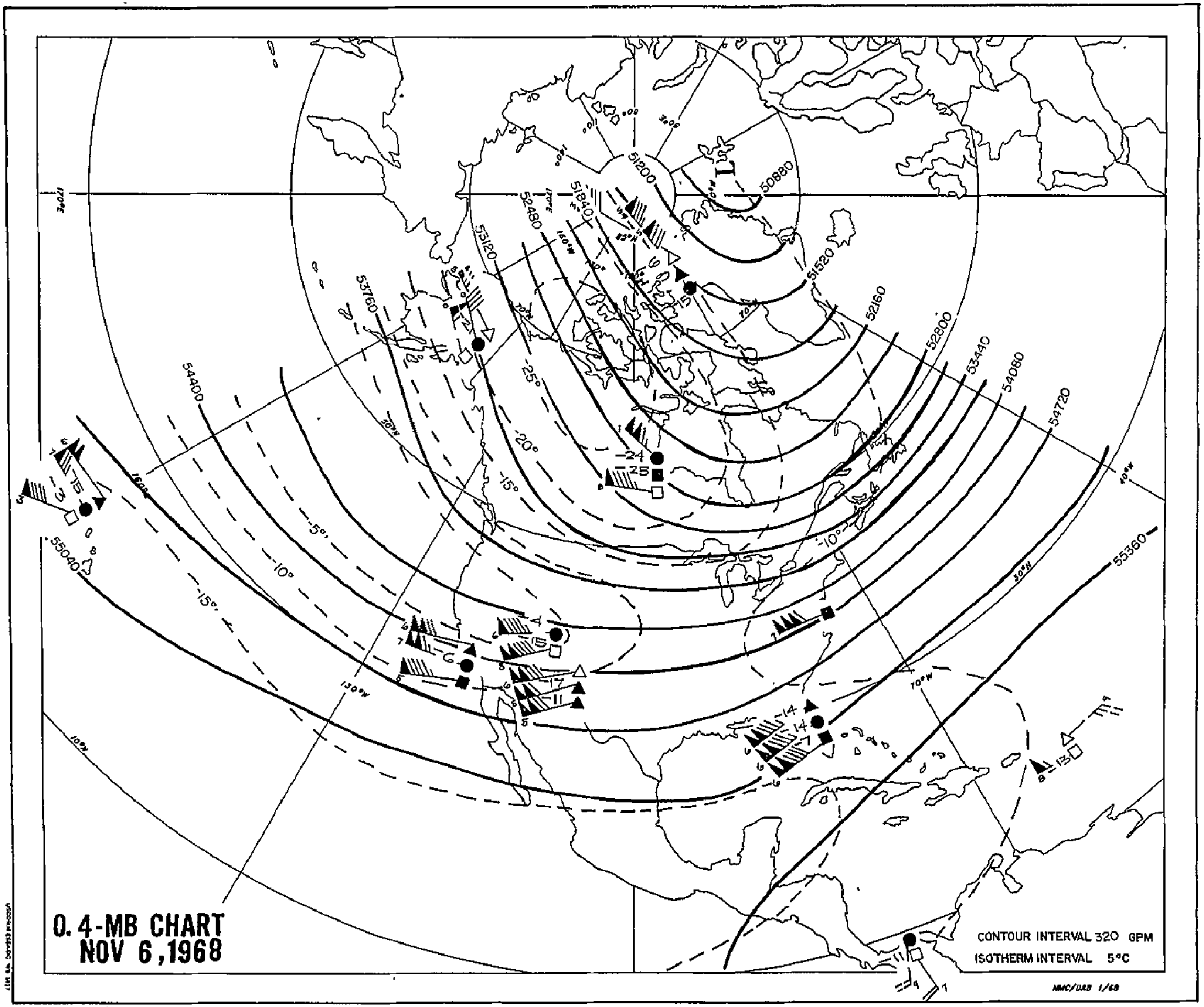

5-MB CHART
OCT 30,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
35520
34880
34240
33920
34560
35200
33600
35840
36000
-35°
-30°
-65°
-60°
-55°
-50°
-45°
-40°
-35°
-30°
-25°
H
L
H

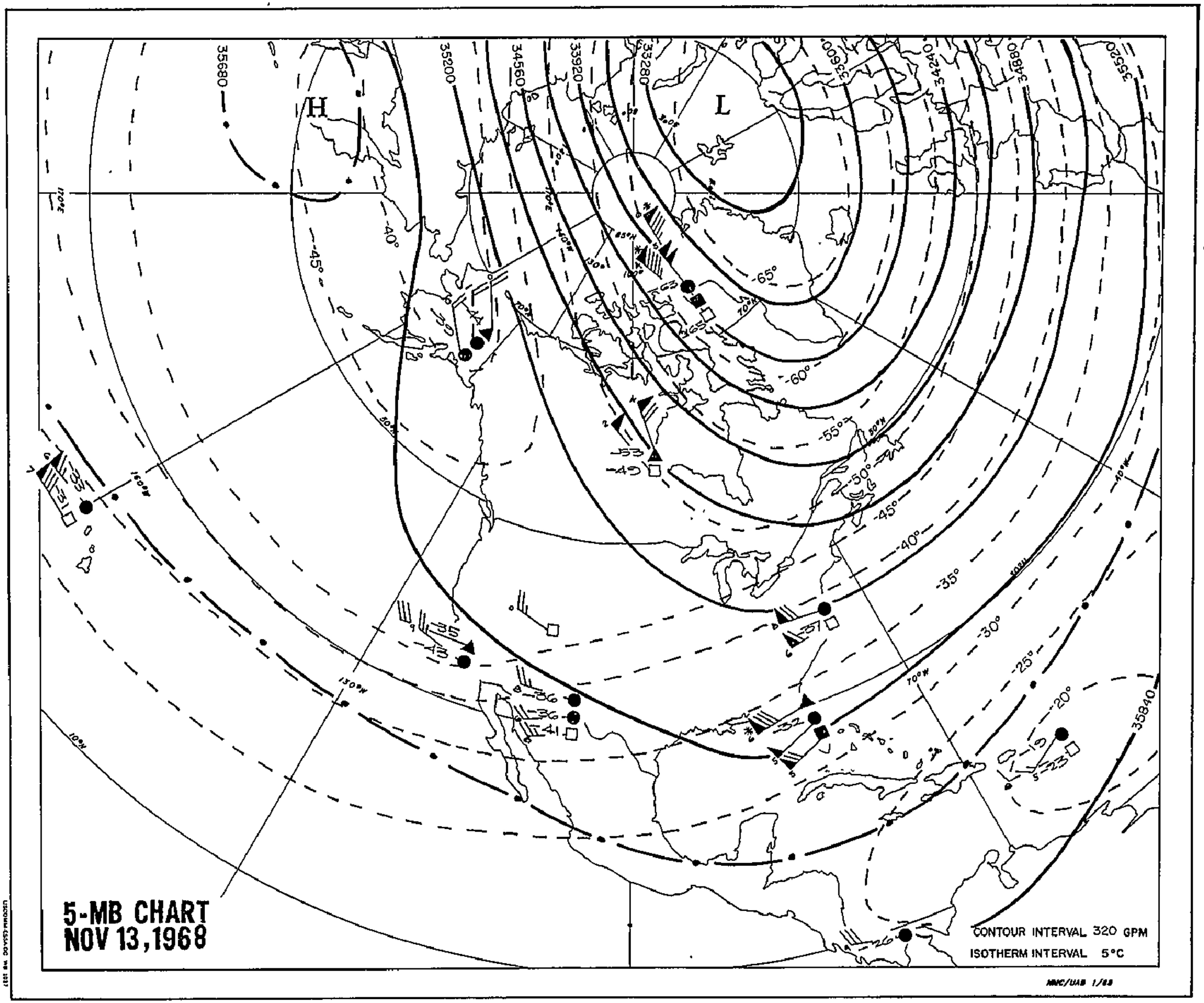

2-MB CHART
OCT 30,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
42240
41600
40960
40320
39680
40000
40640
41280
41920
42560
42880
L
H
-20°
-50°
-45°
-40°
-35°
-30°
-25°
-20°
-15°
-10°
-5°
130°W
70°W

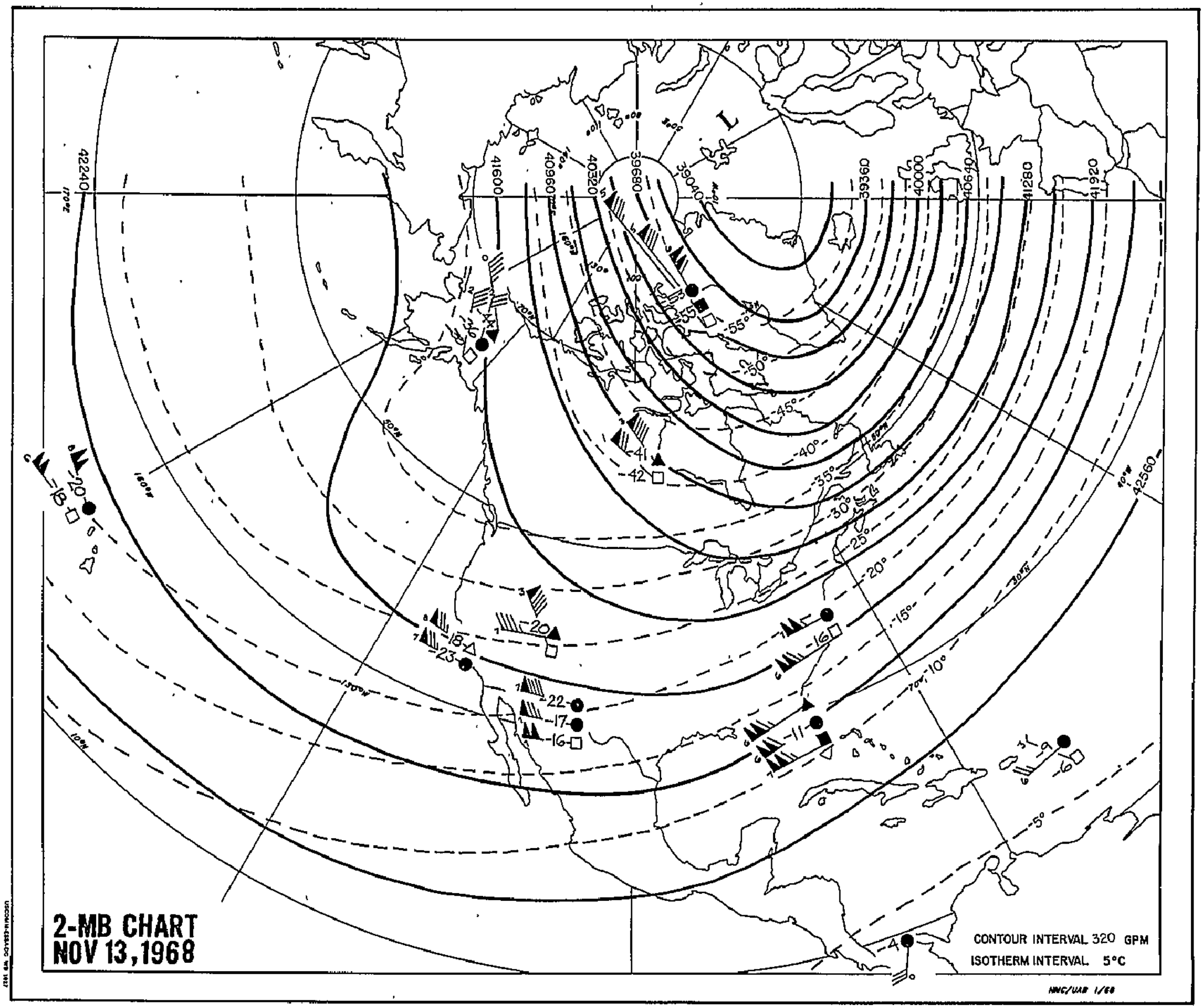

0.4-MB CHART
OCT 30,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
51200
51840
52480
53120
53760
54400
55040
50080
51520
52160
52800
53440
54080
54720
55360
L
NMC/UAB 1/68

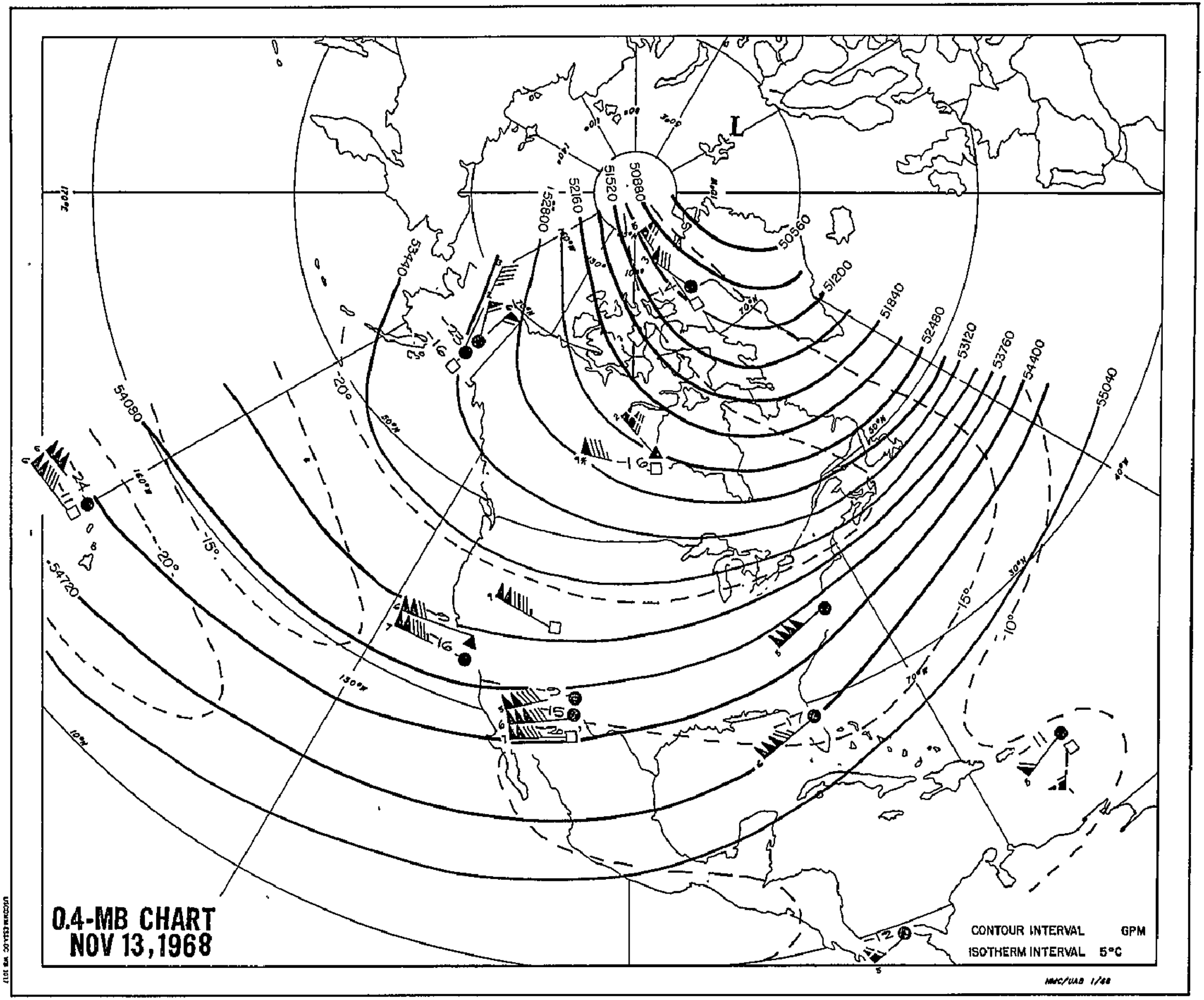

5-MB CHART
NOV 6,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
L
H
35520
34880
34240
33600
33920
34560
35200
35600
35840
-65°
-60°
-55°
-50°
-45°
-40°
-35°
-30°
-25°
-25°

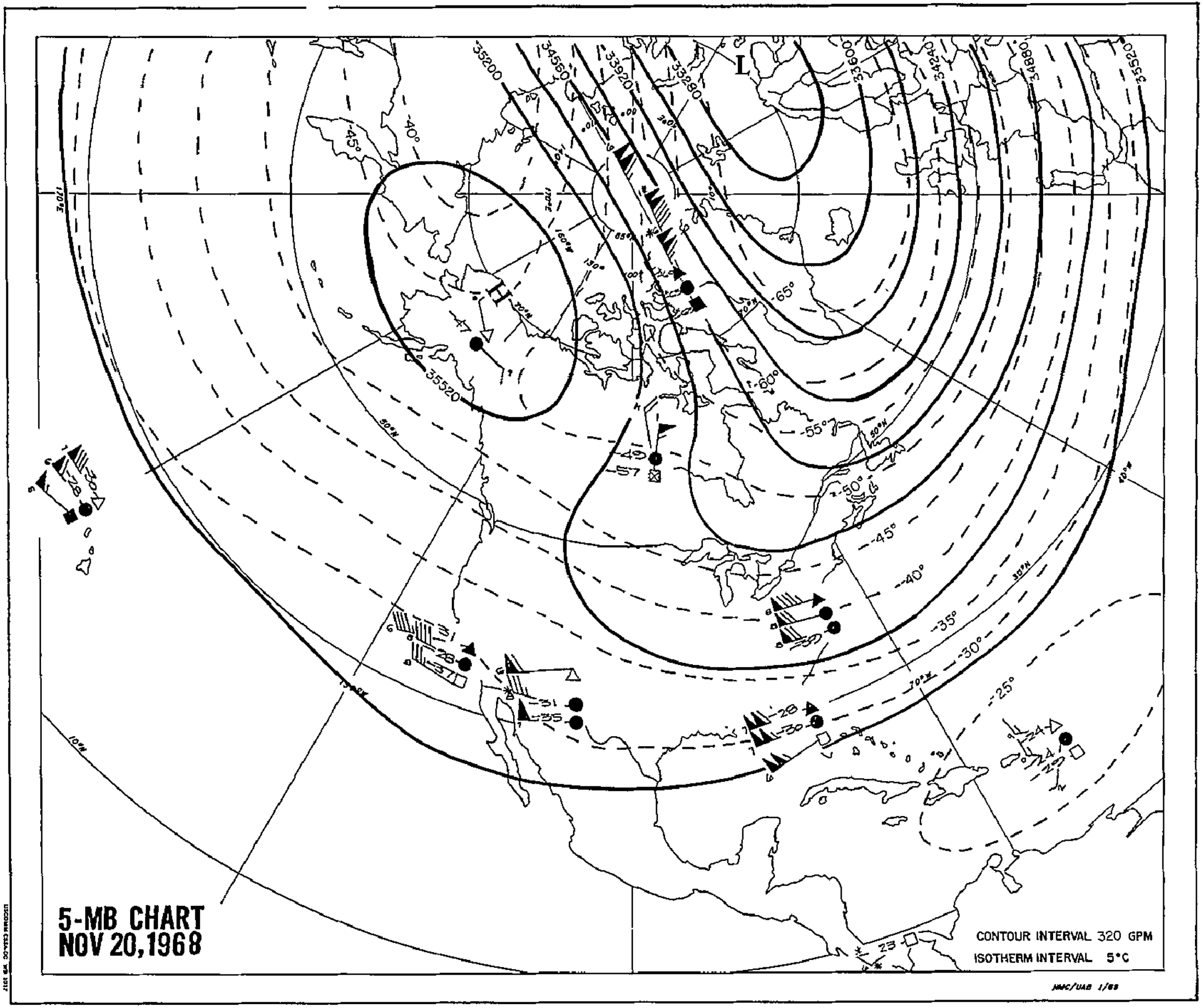

2-MB CHART
NOV 6, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
L
H
39360
39680
40000
40320
40640
40960
41280
41600
41920
42240
42560
42880
-50°
-45°
-40°
-35°
-30°
-25°
-20°
-15°
-10°
-5°
NMC/UAB 1/68

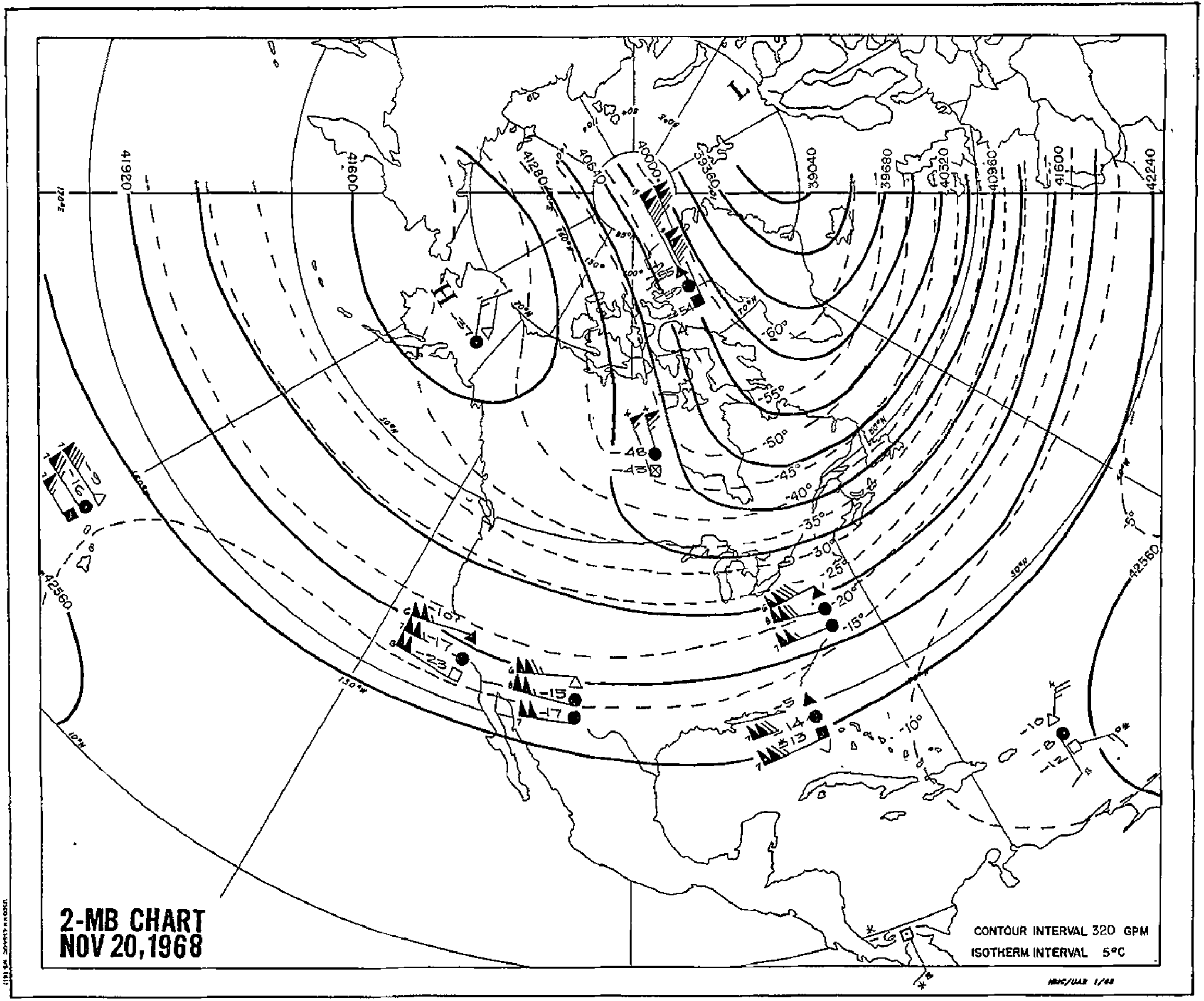

0. 4-MB CHART
NOV 6 ,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
50880
51200
51520
51840
52160
52480
52800
53120
53440
53760
54080
54400
54720
55040
55360
-25°
-20°
-15°
-10°
-5°
-15°
-10°
NMC/UAB 1/69

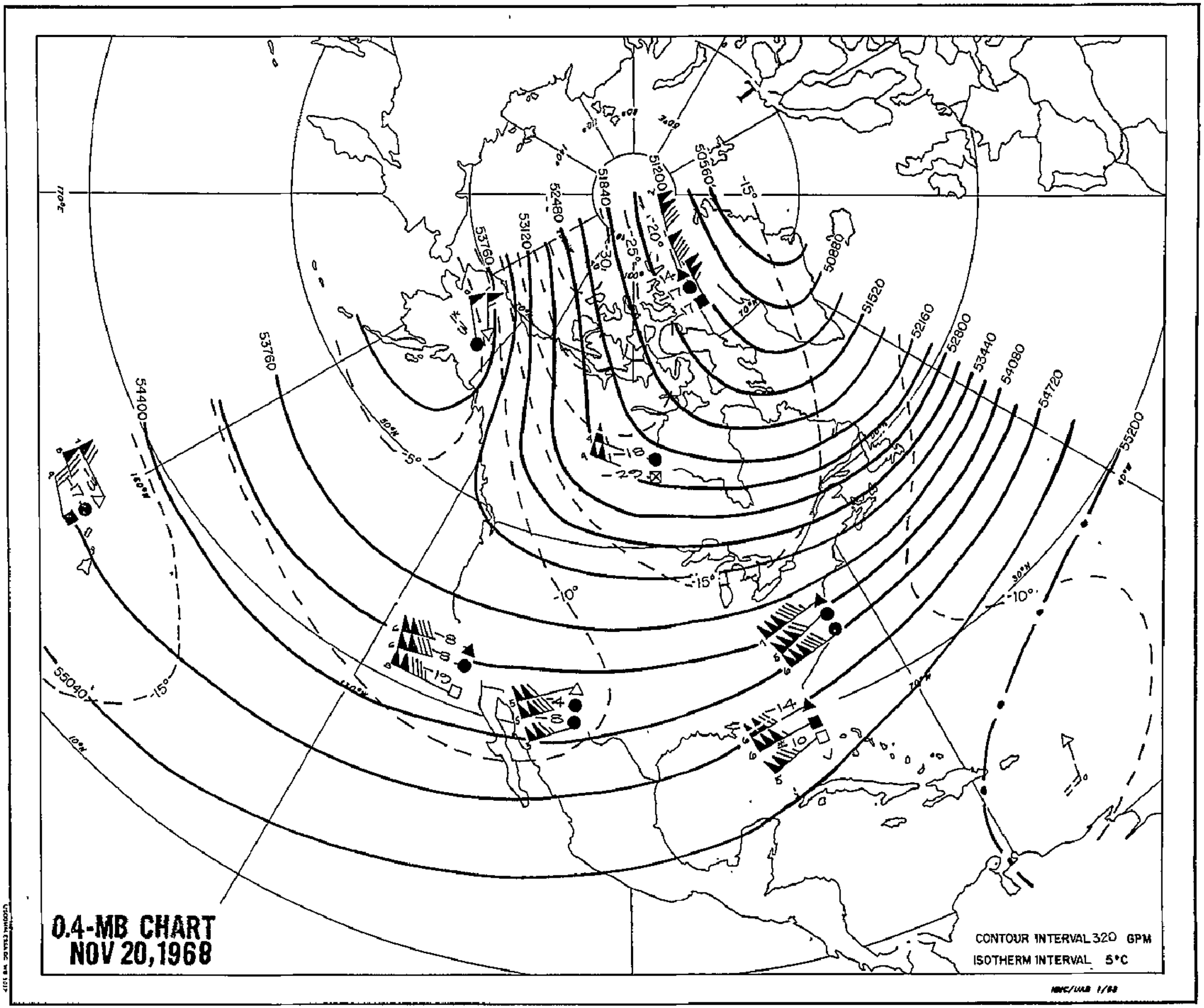

35680
35200
34560
33920
33280
33600
34240
34880
35520
35840
H
L
-40°
-45°
-65°
-60°
-55°
-50°
-45°
-40°
-35°
-30°
-25°
-20°
5-MB CHART
NOV 13,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C

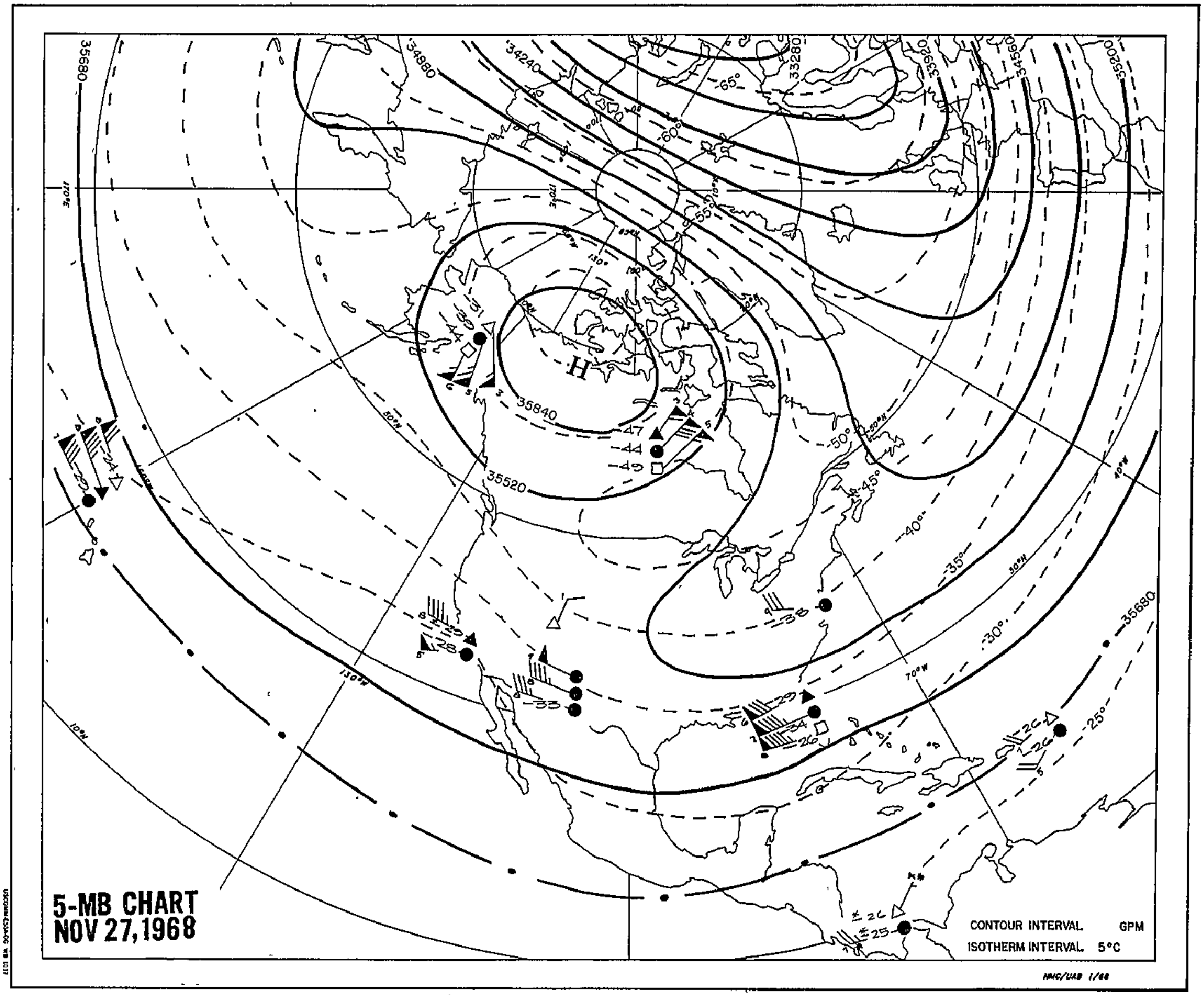

2-MB CHART
NOV 13,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
L
42240
41600
40960
40320
39680
39040
39360
40000
40640
41280
41920
42560
-55°
-50°
-45°
-40°
-35°
-30°
-25°
-20°
-15°
-10°
-5°

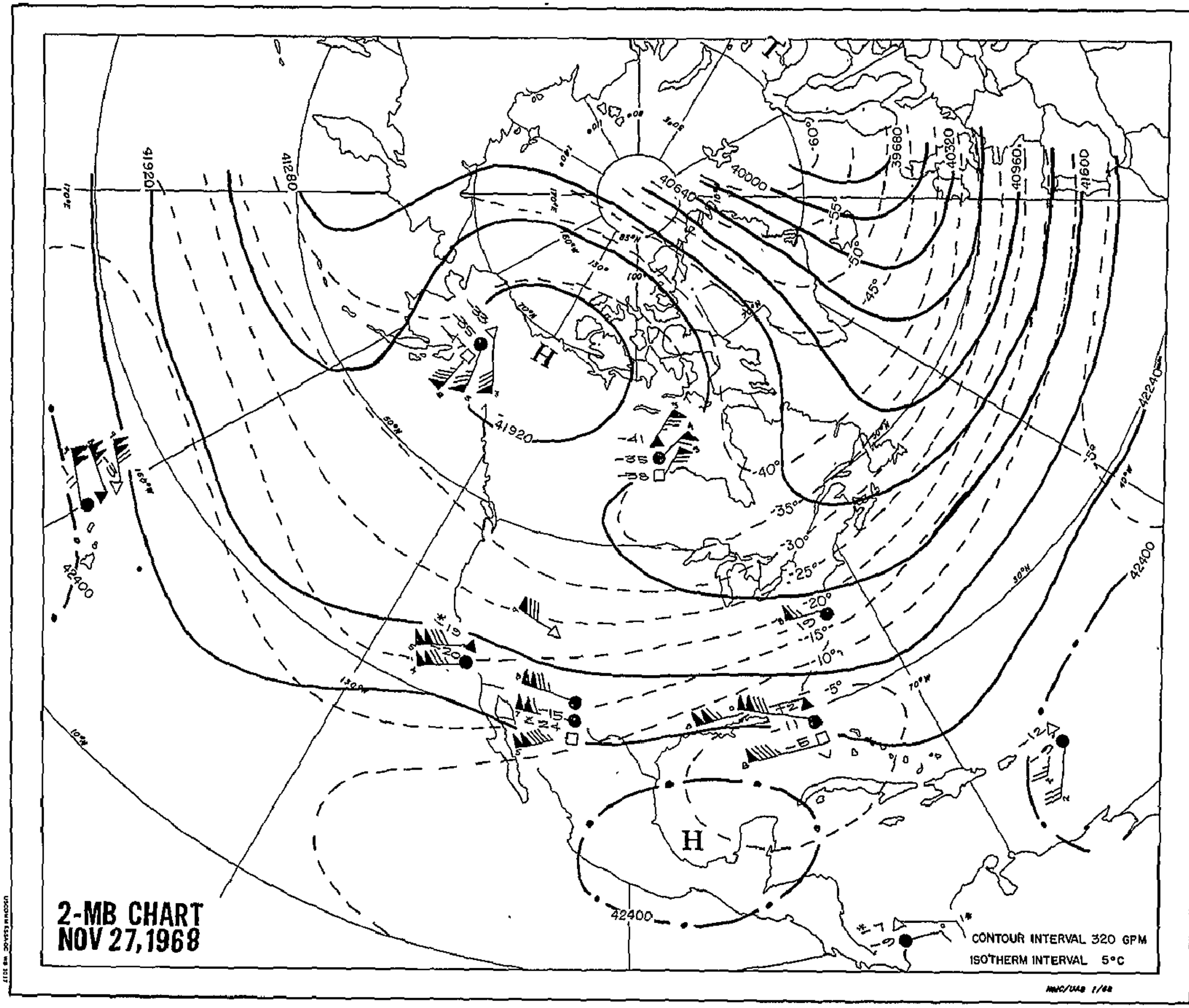

0.4-MB CHART
NOV 13,1968
CONTOUR INTERVAL GPM
ISOTHERM INTERVAL 5°C
50560
51200
51840
52480
53120
53760
54400
55040
50880
51520
52160
52800
53440
54080
54720
-20°
-15°
-10°
L
NMC/UAB 1/68

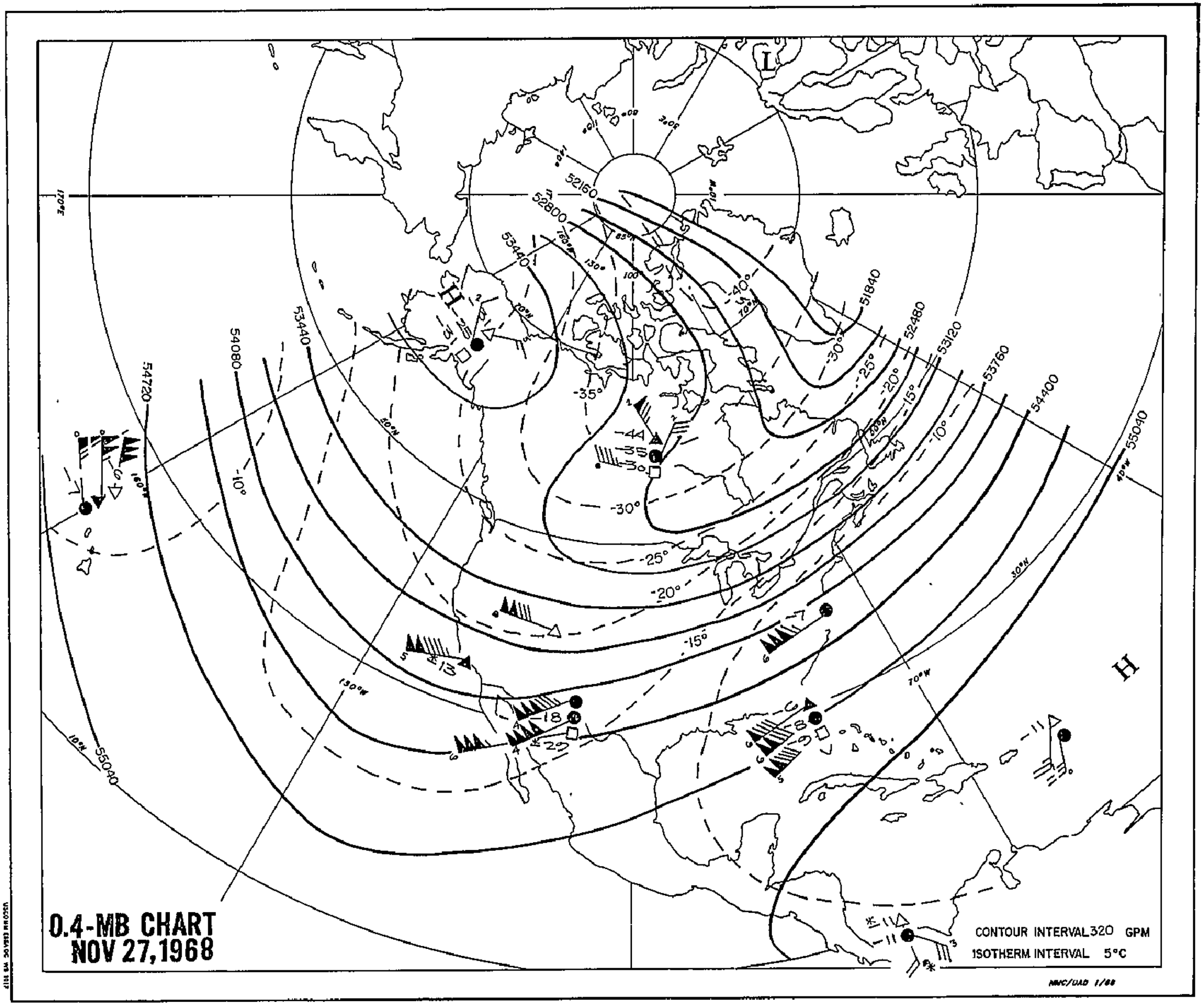

5-MB CHART
NOV 20,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
35200
34560
33920
33280
33600
34240
34880
35520
L
H
-65°
-60°
-55°
-50°
-45°
-40°
-35°
-30°
-25°
NMC/UAB 1/69

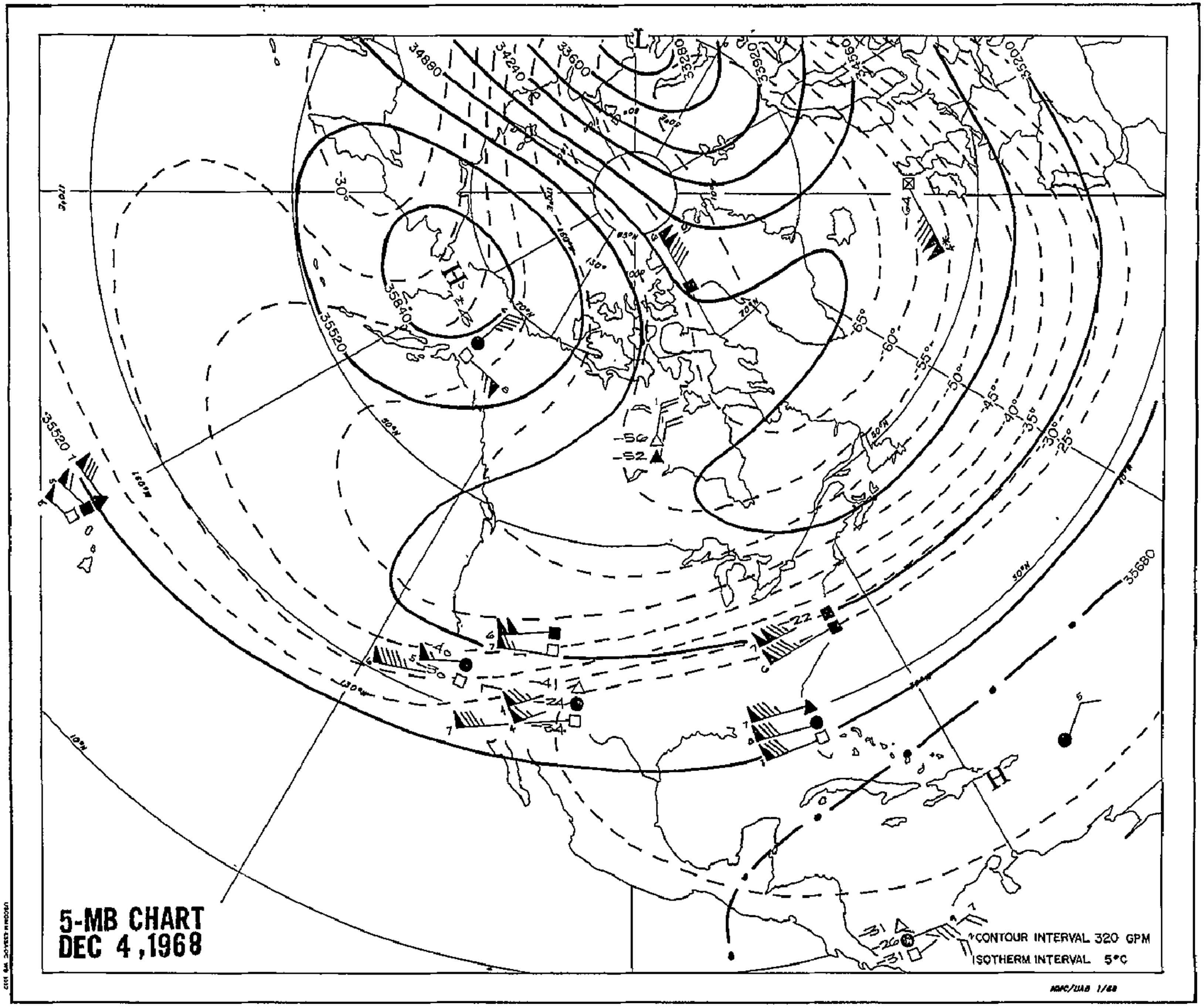

2-MB CHART
NOV 20,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
L
H
41920
41600
41280
40640
40000
39360
39040
39680
40320
40960
41600
42240
42560
42560
-60°
-55°
-50°
-45°
-40°
-35°
-30°
-25°
-20°
-15°
-10°
-5°

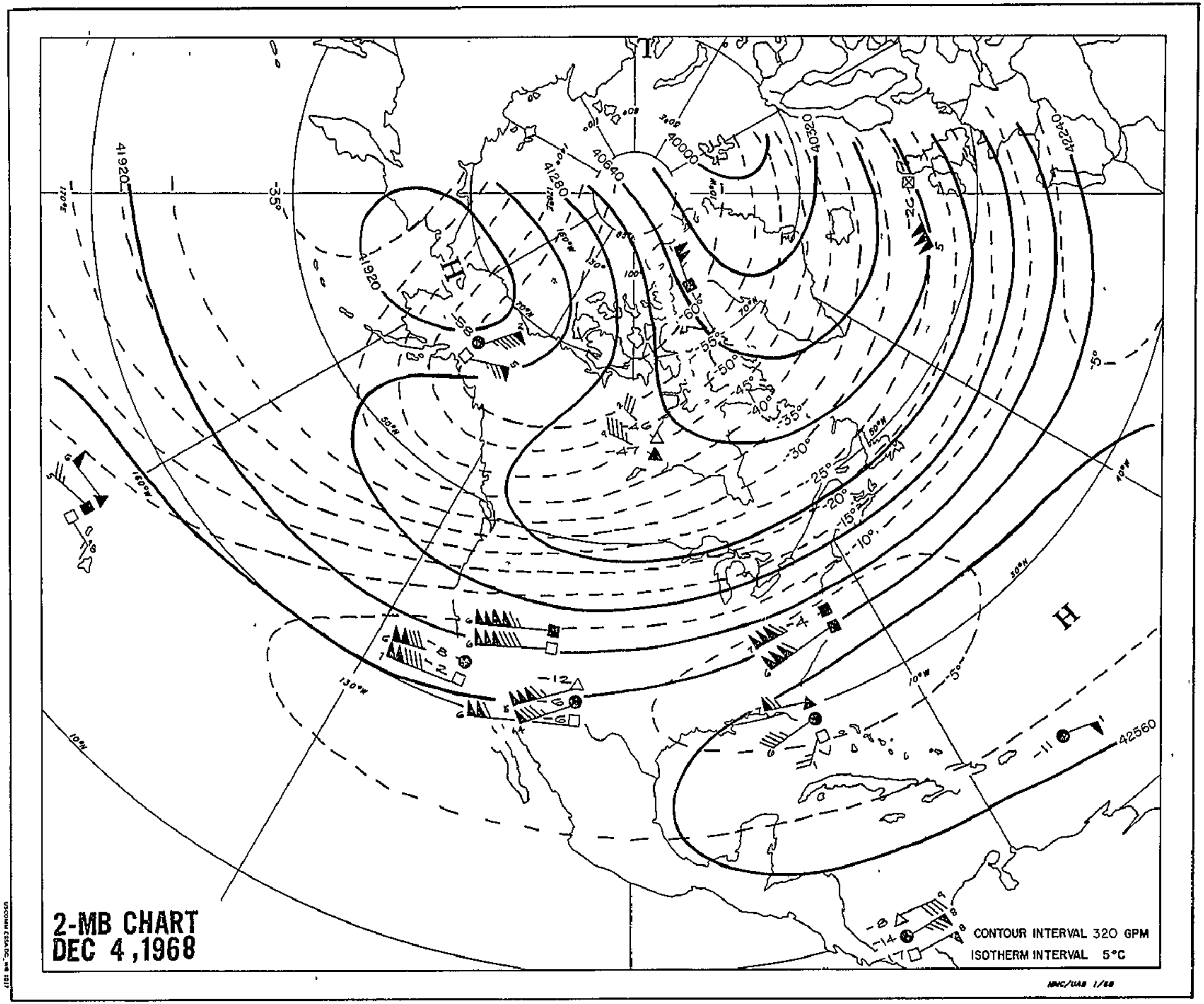

0.4-MB CHART
NOV 20,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
53760
53120
52480
51840
51200
50560
50880
51520
52160
52800
53440
54080
54720
55200
54400
55040
-15°
-20°
-25°
-30°
-5°
-10°
-15°

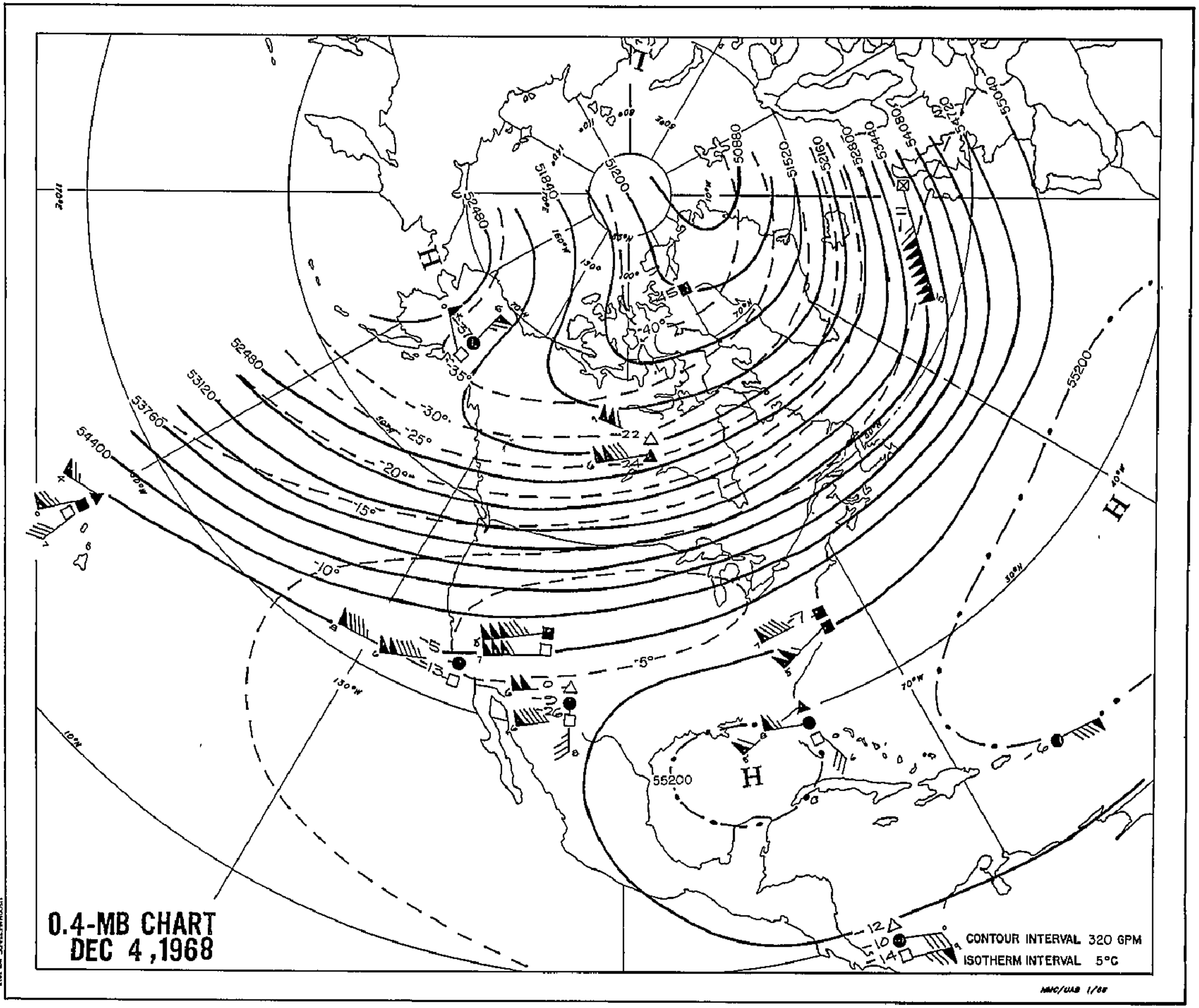

5-MB CHART
NOV 27,1968
CONTOUR INTERVAL GPM
ISOTHERM INTERVAL 5°C
35680
34880
34240
33280
33920
34560
35200
35840
35520
H
-65°
-60°
-55°
-50°
-45°
-40°
-35°
-30°
-25°


2-MB CHART
NOV 27,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
41920
41280
40640
40000
39680
40320
40960
41600
42240
42400
H
H

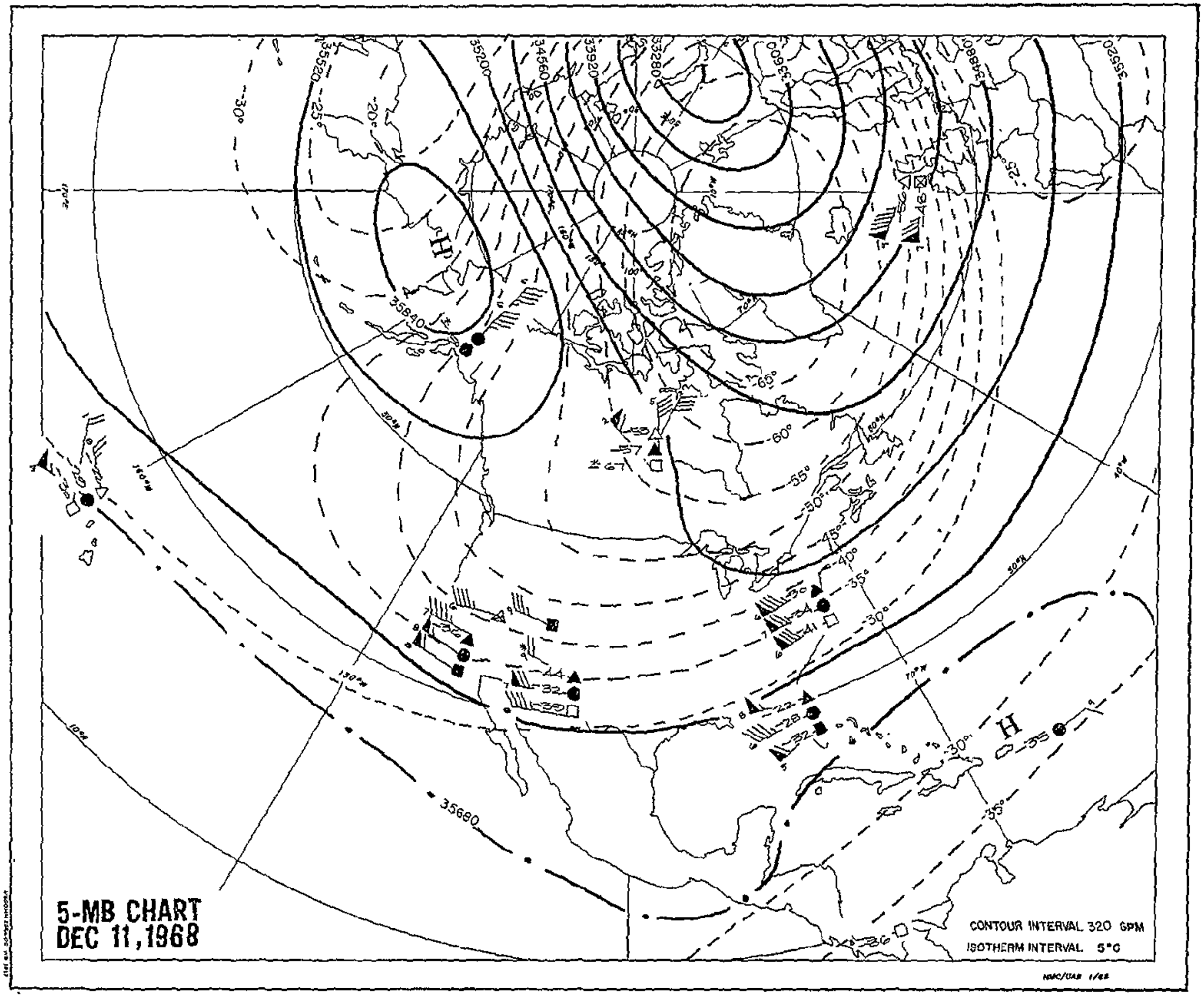

0.4-MB CHART
NOV 27,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
L
H
H
51840
52160
52480
52800
53120
53440
53760
54080
54400
54720
55040
-10°
-15°
-20°
-25°
-30°
-35°
-40°
NMC/UAD 1/68

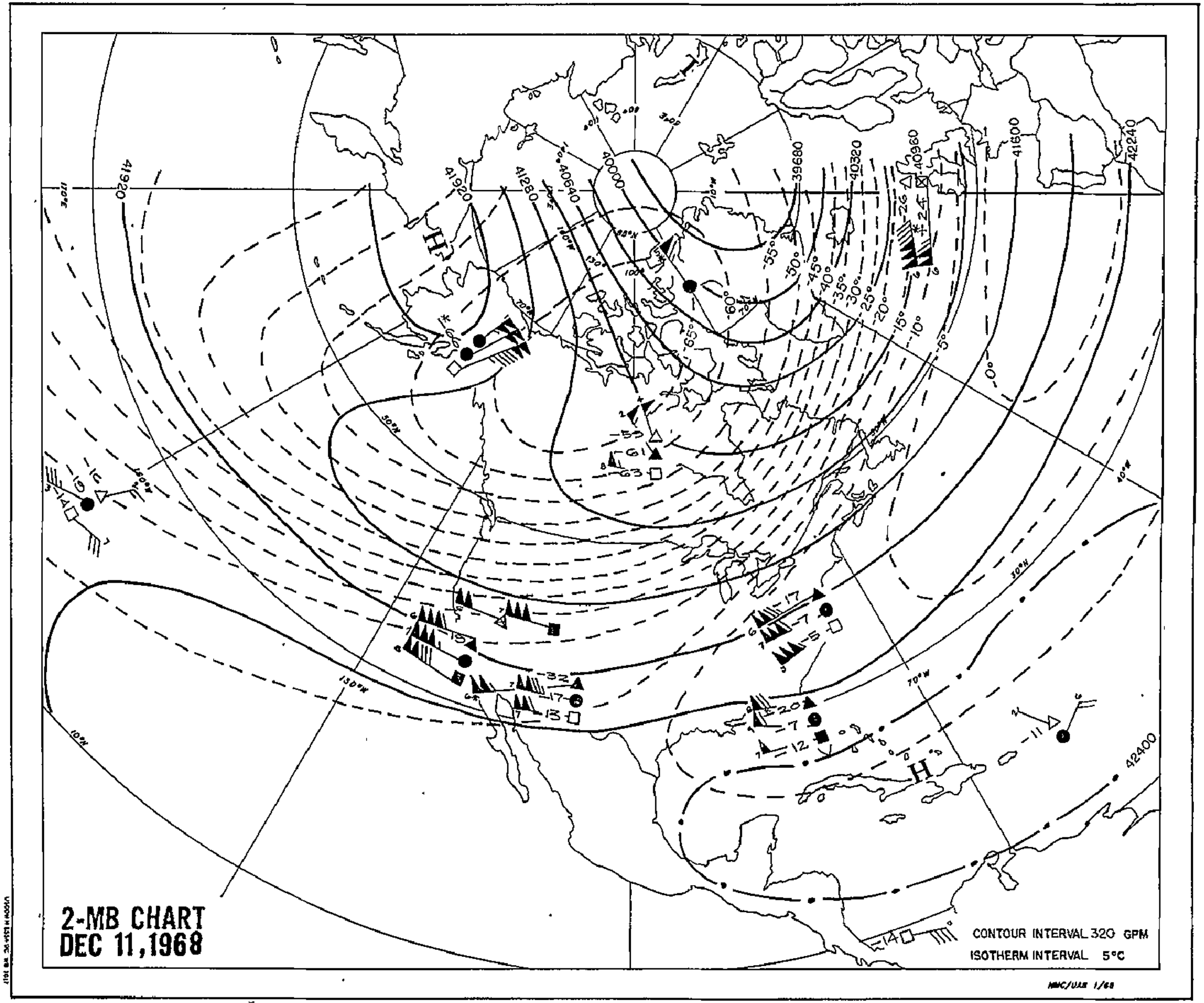

5-MB CHART
DEC 4,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
34880
34240
33600
33280
33920
34560
35200
35840
35520
35680

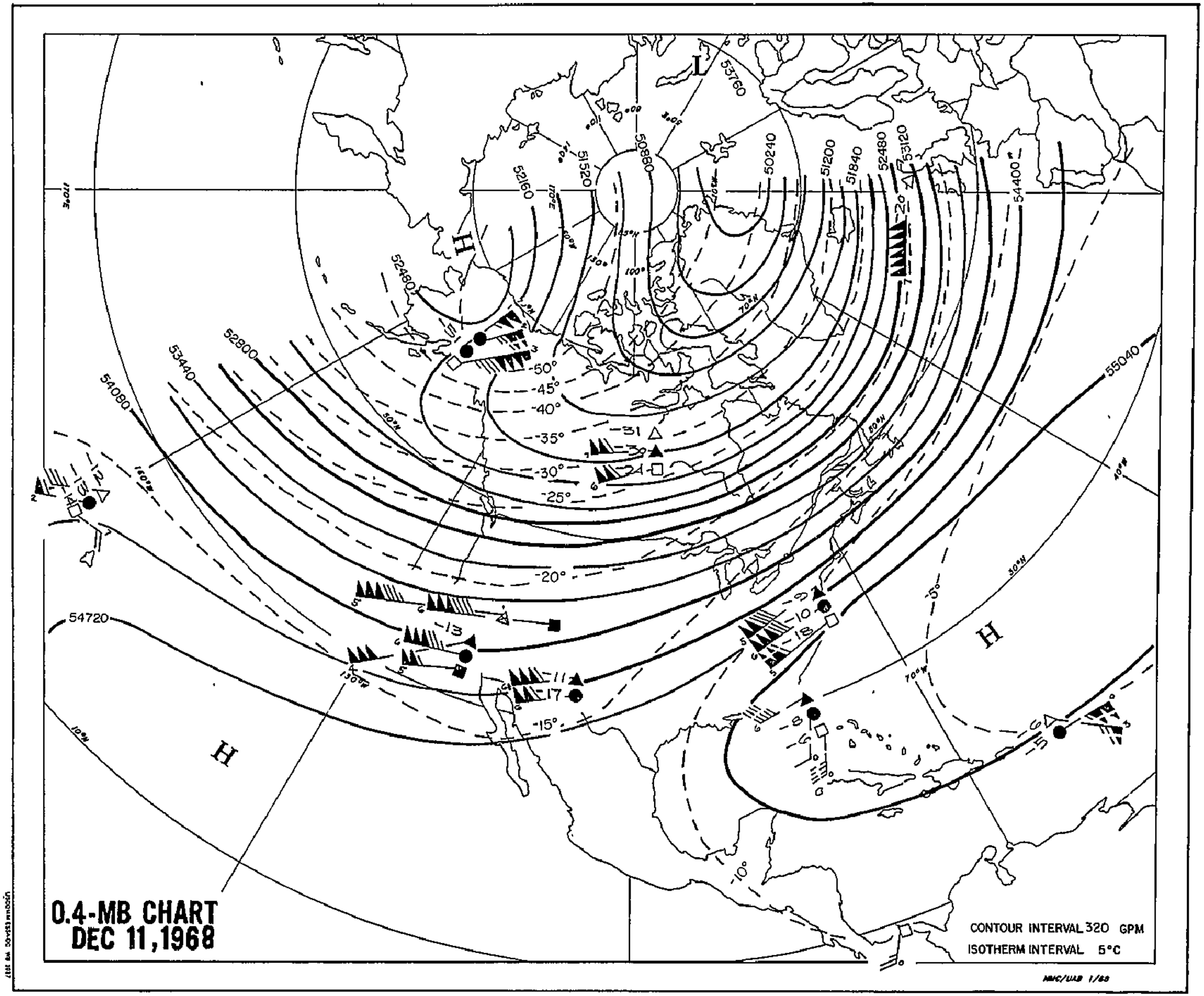

2-MB CHART
DEC 4 ,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C

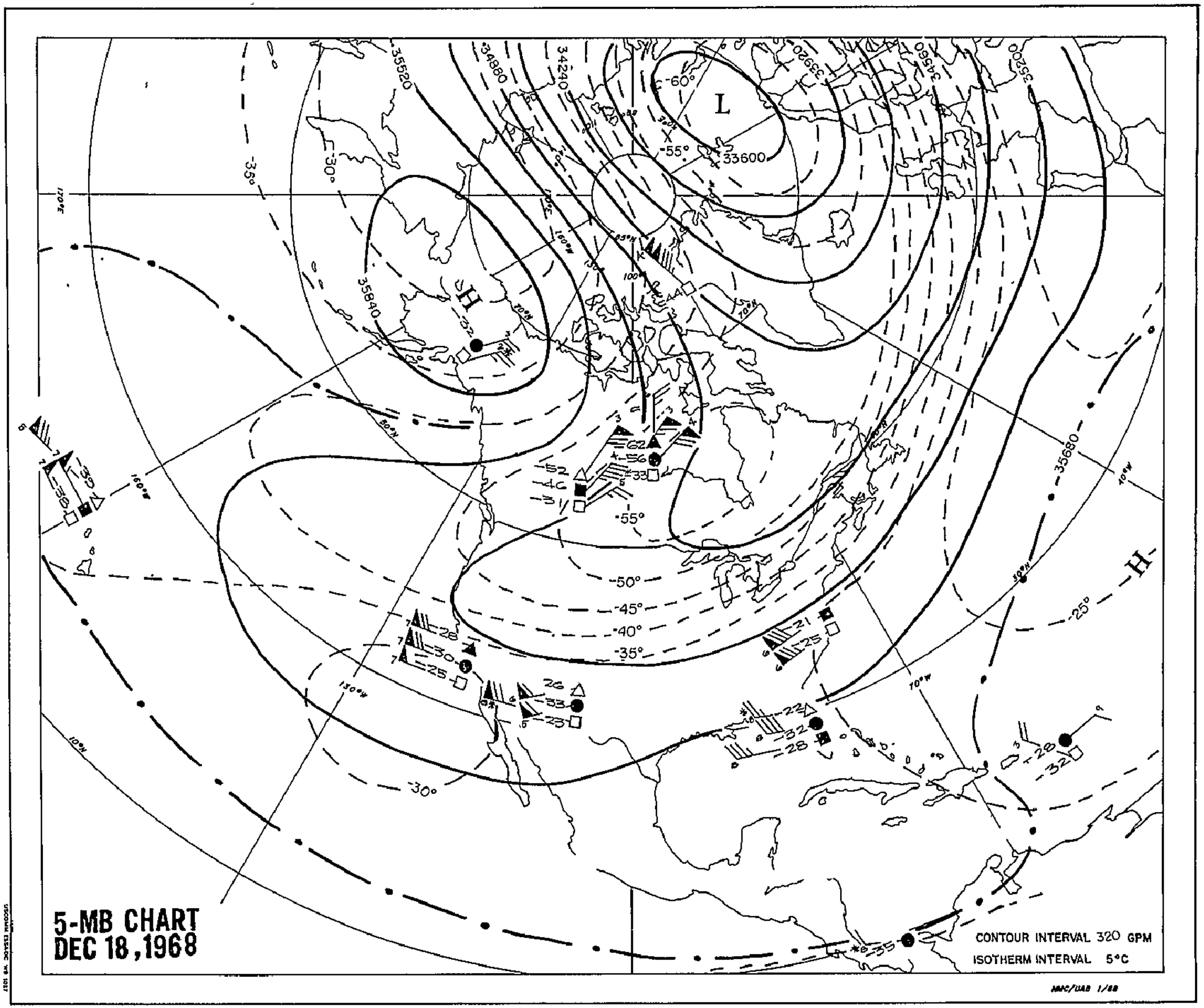

0.4-MB CHART
DEC 4, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
55200
51200
50880
51520
52160
52800
53440
54080
52480
53120
53760
54400
-40°
-35°
-30°
-25°
-20°
-15°
-10°
-5°
H
L

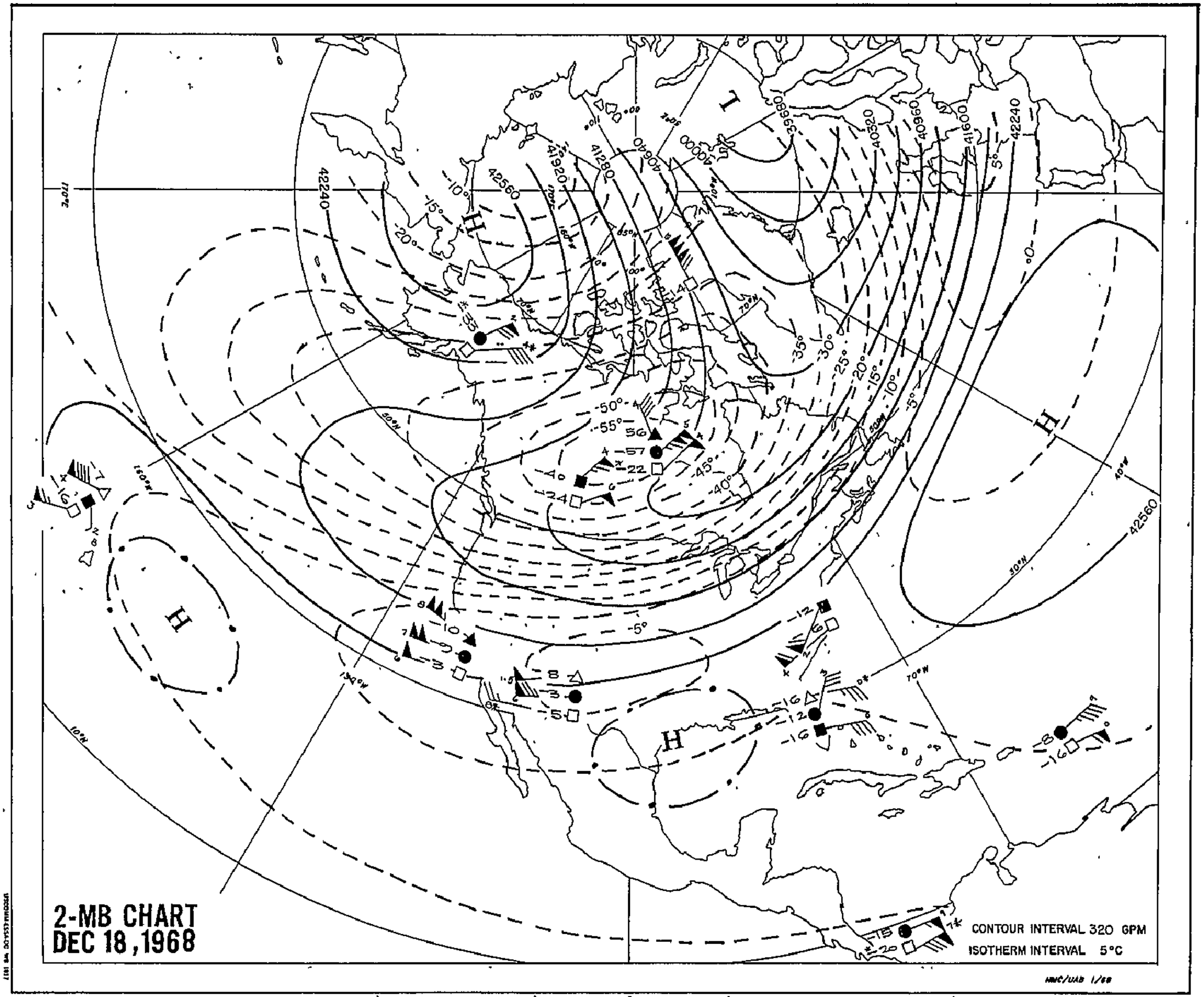
161

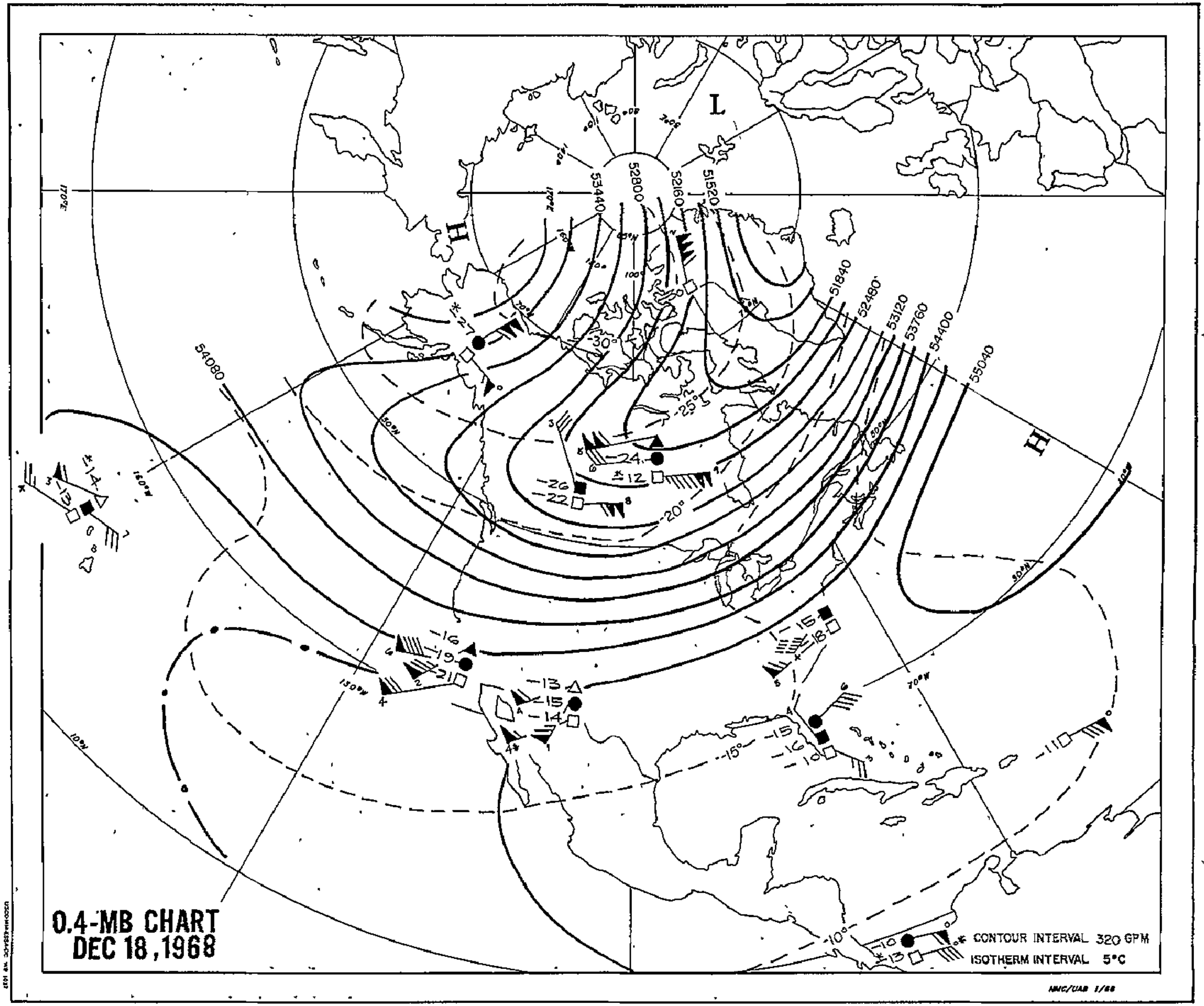

5-MB CHART
DEC 11,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
35520
35200
34560
33920
33280
33600
34880
35520
35840
35680
H
H

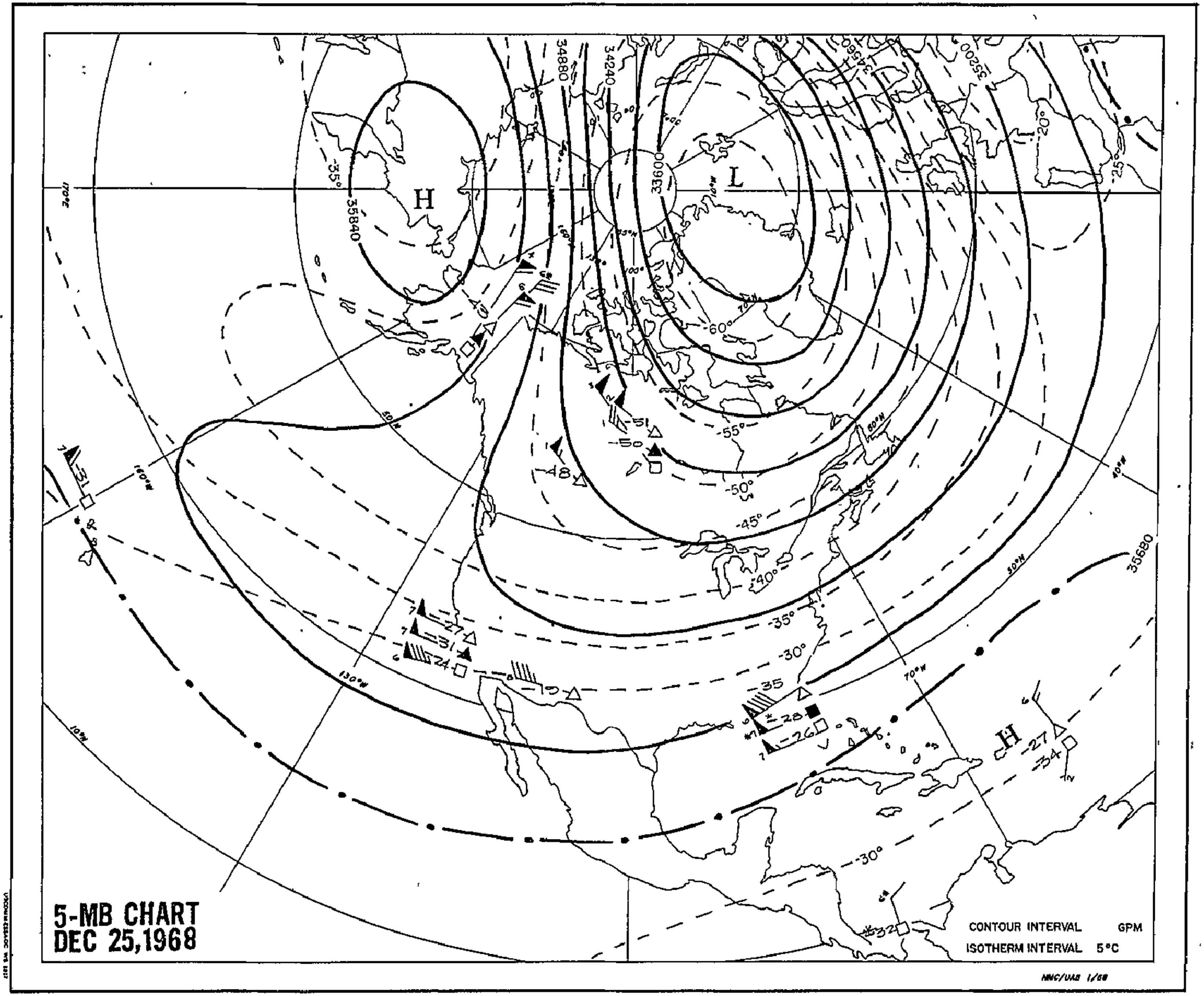

2-MB CHART
DEC 11,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
41920
41600
41280
40960
40640
40320
40000
39680
42240
42400
H
H

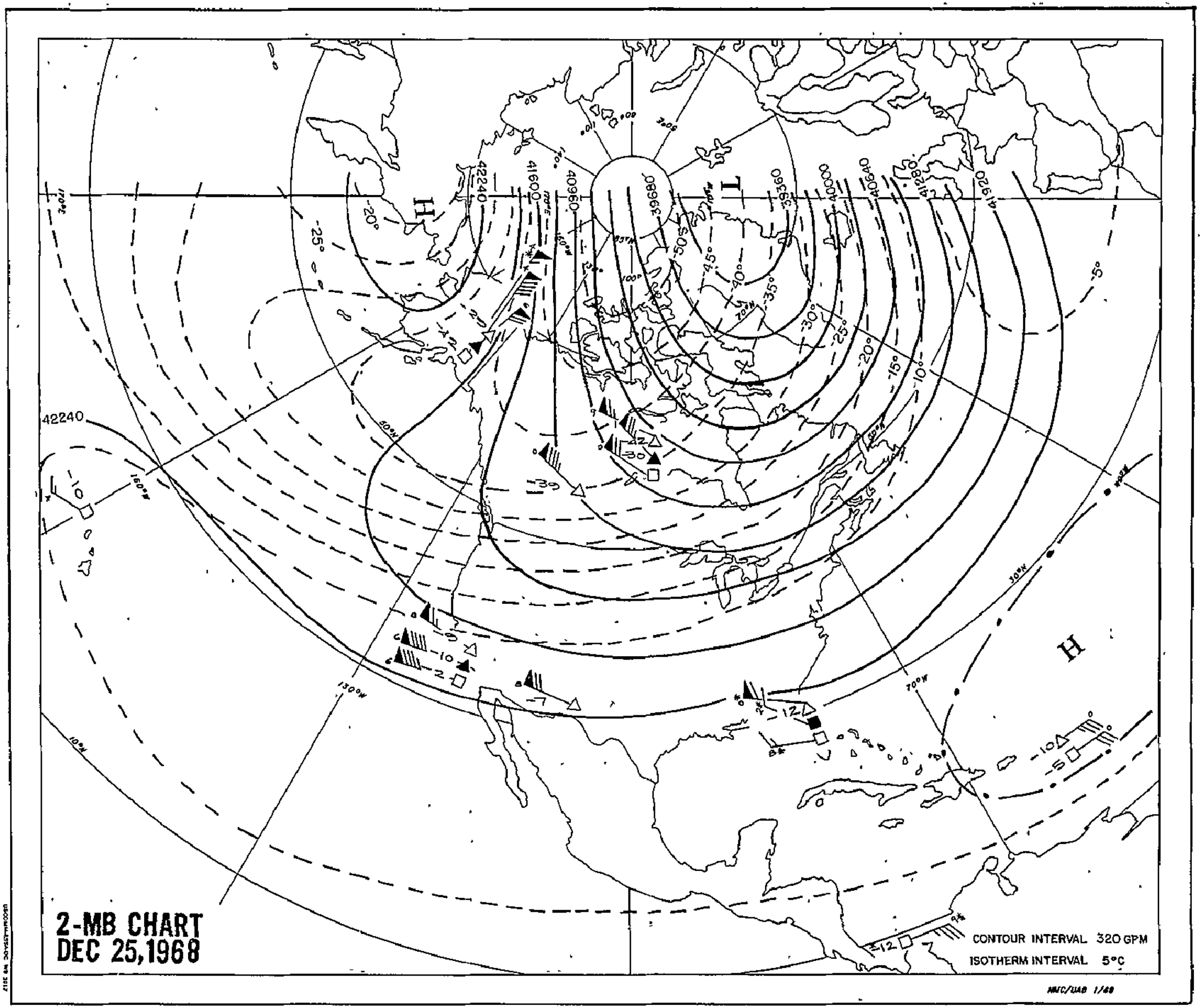

0.4-MB CHART
DEC 11,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
L
H
H
H
50880
50240
51200
51520
51840
51160
52160
52480
52800
53120
53440
53760
54080
54400
54720
55040
-50°
-45°
-40°
-35°
-30°
-25°
-20°
-15°
-10°
-5°
NMC/UAB 1/69

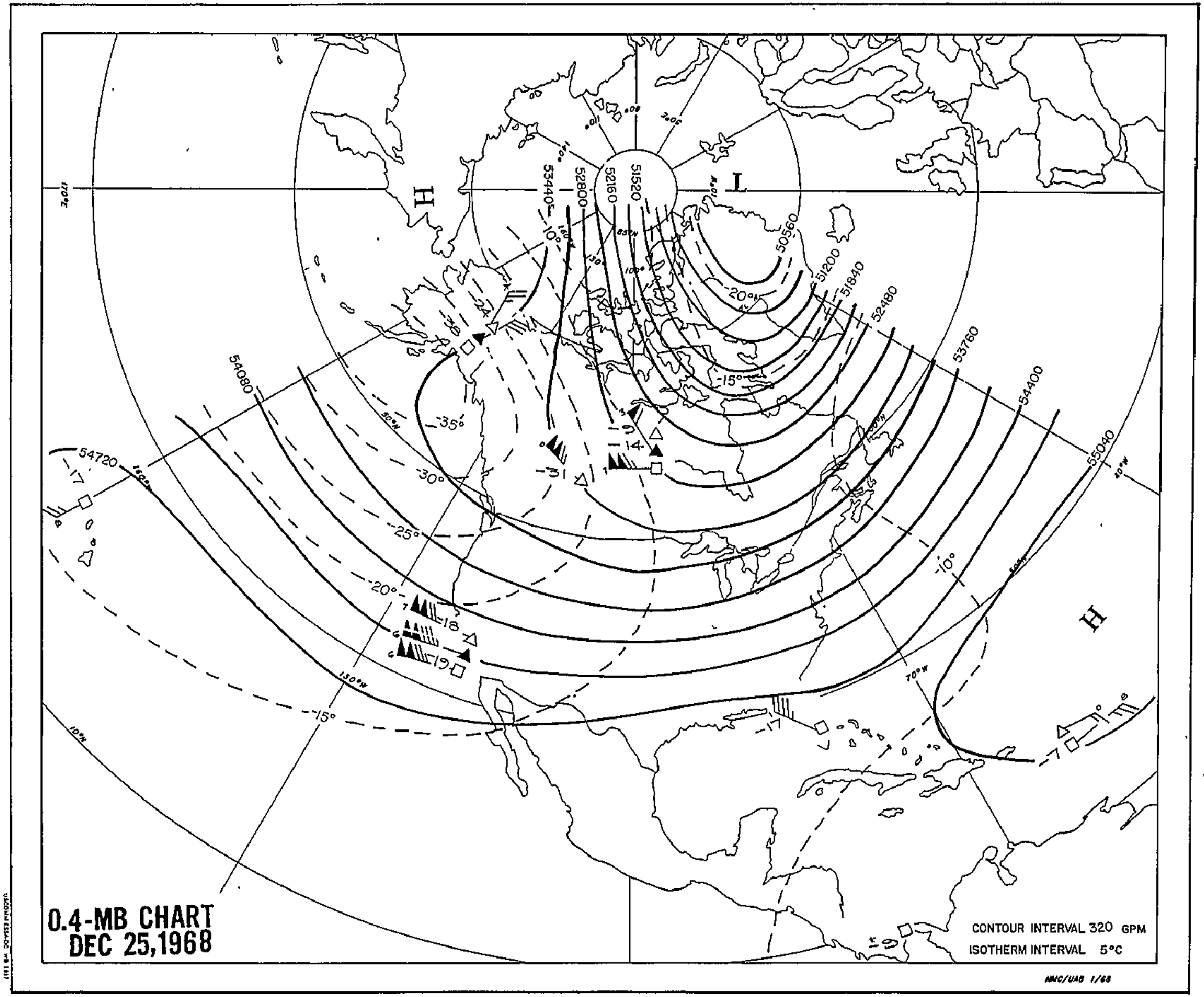

5-MB CHART
DEC 18, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
L
H
H
33600
34240
34880
35520
35840
35680
35200
34560
33920
-60°
-55°
-50°
-45°
-40°
-35°
-30°
-25°


2-MB CHART
DEC 18, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C


0.4-MB CHART
DEC 18, 1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
L
H
H
53440
52800
52160
51520
51840
52480
53120
53760
54400
55040
54080


5-MB CHART
DEC 25,1968
CONTOUR INTERVAL GPM
ISOTHERM INTERVAL 5°C
H
L
H
35840
34880
34240
33600
35200
35680
-35°
-60°
-55°
-50°
-45°
-40°
-35°
-30°
-30°
-20°
-25°
130°W
70°W
NMC/UAB 1/68


2-MB CHART
DEC 25,1968
CONTOUR INTERVAL 320 GPM
ISOTHERM INTERVAL 5°C
H
L
H
42240
41600
40960
39680
39360
40000
40640
41280
41920
42240
-20°
-25°
-50°
-45°
-40°
-35°
-30°
-25°
-20°
-15°
-10°
-5°
130°W
70°W
160°W
10°N
30°N
50°N
NMC/UAB 1/69



☆ U. S. GOVERNMENT PRINTING OFFICE 1971 O - 427-880